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MEETING OF THE NORTHWESTERN ELECTRICAL ASSOCIATION.

The Northwestern Electrical Association is one of the most active bodies representing electrical interests, and twice each year meets in convention to discuss progress in applied electricity. That the association is growing in importance is evident from the quality of the papers presented for the consideration of its members at each successive meeting. At the Milwaukee Convention next Wednesday some excellent papers will be read, bearing upon subjects deserving of most thorough discussion. The question of municipal ownership will come up for consideration in the form of a committee report, and, it is stated, the report will be against the idea. Municipal ownership is at the present time engaging the attention of the authorities in many Western cities, so that if the committee's report is unfavorable to the notion, and presents strong arguments against it, a public service would be rendered by forwarding a copy of the report to the public officials in all places that are wavering in their convictions regarding public and private ownership of electric light plants. Extraordinary preparations have been made to make the Milwaukee meeting an enjoyable and successful one, and we trust that all will derive some practical benefit by being present.

NIAGARA POWER BANQUET.

On Nov. 19, 1896, the long talked of transmission of electrical power from Niagara Falls to Buffalo became an accomplished fact, and the ceremony attending so important an event was of a very informal character. It was intended, however, to fittingly celebrate the occasion at a later date, and the deferred celebration took place on the night of Jan. 12, 1897, under the most felicitous circumstances. The mighty forces of the world's progress were brilliantly represented—capital, industry and science—and such a gathering of men of eminence in these fields it is safe to say was never before brought together. The banquet was an elegant and dignified affair, and the addresses that were made in response to toasts were devoid in most cases of the studied rhetorical effects that are usually indulged in on such occasions. The gentlemen there were deep thinkers and unaccustomed to clothe their words in superficial glamor.

What most of them said was of a practical nature. They were not gathered together merely to gratify their animal propensities, but to mark, in the most dignified manner possible, one of the most important industrial events this country has ever witnessed. There is no question that the meeting was a decided success in every way.

Mr. Tesla, who was the guest of honor, received a most enthusiastic ovation, but in his remarks he was somewhat disappointing. His theme was a broad one—electricity—but he really said very little about electricity. He pleaded embarrassment in addressing such an audience, and possibly the disadvantage under which he thus labored was the cause of his disjointed ideas. Many of his hearers no doubt expected Mr. Tesla to reveal some great truths in electrical science, but unfortunately he did not come so prepared. The address of Mr. Francis Lynde Stetson was a practical one, dealing with the historical and business sides of the Niagara power industry. He hoped that the extensive and continuing use of Niagara power in Buffalo City would result in material and financial advantage to those now producing nearly 40,000 horse-power from steam engines at twice the cost of Niagara power.

The celebration, although it might have been of a more popular character, inasmuch as the occasion was certainly one deserving of

the popular demonstration that usually accompanies important public events, is nevertheless destined to prove memorable in the history of electrical progress, both for the distinguished guests present and the important occasion which it commemorated.

THE "SKIN EFFECT."

Although the general principles underlying the so-called "skin effect" of conductors may be said to date from the writings of Maxwell—and notwithstanding the elaborate discussion which the subject has received by many writers, most prominent among whom are Lord Rayleigh and Oliver Heaviside, while Hughes and Kelvin have furnished valuable experimental demonstrations—yet the question is one which has as yet not materially entered into engineering problems, a fact perhaps mainly due to the more or less empirical manner in which line construction is at the present time carried out. Both in telephony and in the transmission of power to long distances, engineers have felt their way and the development has taken place by gradually extending lines which have been made to work satisfactorily. In fact, this may be said to be the method pursued in all branches of engineering and some have gone so far as to state that theory follows practice rather than the reverse, a statement, however, it is needless to say will not bear rigid examination.

In other columns of this issue Prof. Jackson treats of the "Conductor Resistance Met by Alternating Currents," introducing a question which may within a few years prove to be one requiring consideration from a commercial standpoint. It is more than likely that when such time arrives and the use of alternating currents has been extended to railway systems, the rail return will have been abandoned or more largely supplemented than in present practice by copper return feeders. From the standpoint of long-distance transmission, both of power in large quantities and telephone currents, the "skin effect" will be considered in engineering problems more than has been the case in the past. In power transmission the effect is not so important a factor, owing to the modern tendency of employing very low frequencies, but inas much as the resistance and self-induction of conductors carrying high frequency currents are materially altered, the "skin effect" becomes more important in telephony. It will be largely by the most careful consideration of these factors together with those of capacity and leakage that the present excessive cost of line conductors will be reduced and the transmission of speech accomplished under the most economical conditions. The empiricism of the present day will be compelled to make room for more exact methods and the theoretical discussions of the past will largely influence the methods of practical working.

THE RAILROAD COMMISSIONER'S REPORT ON ELECTRIC RAILWAYS.

The last annual report of the New York State Board of Railroad Commissioners is a document full of interest and instruction to electric railway managers, and, indeed, to the public at large. Steam railway affairs, of course, occupy the major portion of the Commissioners' report, but the space devoted by the Board to street railway matters is noticeably expanding each year as the subject grows in importance. The report contains many suggestions and statements which show that the Commission is keenly alive to the interests of the people.

The subject of the abolition of grade crossings is always a most important one for consideration and the Commission makes some pertinent remarks under this head. The enactment into law of pending legislative suggestions would bring about a condition of things that is earnestly desired but extremely difficult to realize. There is no question that grade crossings can be abolished, neither is there any doubt as to the advisability of abolishing them. These propositions are unassailable; the difficulty lies in the hesitancy of those directly affected in assuming the burden of expense such an improvement would entail. The dangers of grade crossings are so well known that they need not be especially emphasized. Almost every day grade-crossing accidents are chronicled in the daily papers, and in large cities the dangers are particularly grave. The subject will always be one of prime importance to railroads and public alike, and the Railroad Commissioners, appreciating this fact, would be derelict in their duty if they relaxed their endeavors to bring about the much desired relief. Their efforts will avail little, however, without the support of the public. Signals, gates and other appliances at crossings, while good in a limited way, cannot always be relied upon as preventatives of accidents. Apart from these considerations many advantages that would accrue to the railway companies by the abolition of grade crossings are pointed out by the Commissioners, and altogether this one subject deserves the most careful consideration of the interests involved.

The Commissioners indulge in a little idol-smashing in the statement that a thoroughly efficient fender for electric cars does not seem to have made its appearance. This assertion will no doubt surprise the army of inventors, individually and collectively, who have produced what each thinks is the perfect solution of the fender problem. The fact is, however, that the problem is a much more difficult one to solve than most people realize, and while there are some very meritorious devices in the market they all lack the one essential quality of reliable action at all times and under all circumstances.

The treatment of passengers by employees of the street railway companies receives the attention of the Commissioners. The Board suggests that employees should be courteous to passengers, and we are of the same mind, but we are constrained to remark in this connection that the public, too, might exercise more courtesy toward employees. While it is far from us to close our eyes to any acts of discourtesy on the part of employees toward passengers, we must confess that, as far as our observation goes, violations of the ethics of good breeding are more on the side of the public than the employees.

The report touches on many other subjects of practical interest to street railway management, and for the benefit of those interested we present on another page of this issue a full abstract of that part having a direct bearing on street railway interests.

The Davy-Faraday Research Laboratory.

The Davy-Faraday Research Laboratory was opened by the Prince of Wales on Dec. 22, last. The laboratory was presented to the Royal Institution by Dr. Ludwig Mond, who donated the sum of $500,000 for its construction, equipment and maintenance. It is to be devoted to research in physics and chemistry under the directorship of Lord Rayleigh and Prof. Dewar. It is to be non-sectarian, and any one who can satisfy the Laboratory Committee that he is qualified to undertake original scientific research in pure and physical chemistry, is eligible for admittance, preference being given to those who have already published original work. In the course of his remarks at the opening exercises, Dr. Mond said that he had intrusted the laboratory to the Royal Institution so as to insure its being open to men and women of all schools and of all views on scientific questions. Those desiring to carry out research work in the laboratory should make application to the assistant secretary, Royal Institution, who will furnish desired information. As this is the only institution of its kind in existence the working of the Davy-Faraday research laboratory is destined to have most important effects on the future of science, and will also lend most material service by instigating the endowment of similar institutions in other countries.

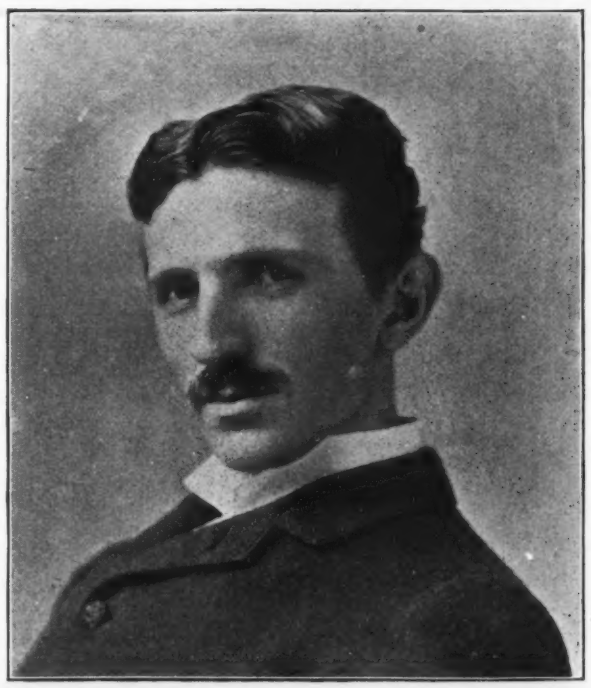
Niagara Power Banquet.

The banquet given by the Cataract Power & Conduit Company at the Ellicott Club, Buffalo, N. Y., on the night of Jan. 12, to celebrate the successful transmission of power from Niagara Falls to Buffalo, was one of the most brilliant affairs of the kind ever held, and was a magnificent success in every way. The attendance, which numbered over 400, included many of Buffalo's wealthiest and most influential citizens and business men, professional men, capitalists and about 30 eminent electrical engineers and others connected with the electrical industry in its various branches.

The hospitality was sumptuous, and the dignity and character of the guests will place the event among the most historic and notable affairs which have ever taken place in electrical circles. The menu cards were unique in conception and elaborate in design. Their covers were made of aluminum produced at Niagara Falls by means of the great power the successful transmission of a portion of which to Buffalo was the occasion of this celebration. On the covers were engraved the name of each guest. The guests were seated at eight tables, arranged in rows, each table accommodating about 50 persons. The menu was the best that the highest culinary skill could devise. and after it was disposed of the guests entered into the enjoyment of their cigars and the toasts which followed.

Mr. Francis Lynde Stetson, first vice-president of the Cataract Construction Company, acted as toastmaster.

In the course of his remarks in response to the toast on the "Niagara Power in Buffalo," Mr. Stetson said that shortly after enterprising citizens of Buffalo had proposed to give $100,000 as a prize for the device of a practicable method of using the Niagara power in Buffalo, there was organized in 1886, exclusively by citizens of Niagara Falls, a company, which since 1889 has been known as the "Niagara Falls Power Company," or the "Tunnel Company," and which in 1889 entered into a contract for the construction of its works at Niagara. The Cataract Construction Company has in the course of six years, without receiving a penny of profit or dividends or interest, provided for expenditures exceeding $6,000,000, exclusive of interest. Notwithstanding the fact that the employment of the power at Niagara could be made much more profitable than its transmission elsewhere, it was and is impossible that the company should not recognize the ultimate benefits both to itself and to this community of providing for the use of power in the enterprising city of Buffalo. In October, 1894, the Niagara Power Company made application to the local authorities in Buffalo for the right to introduce Niagara power into the city, an



NIKOLA TESLA.

application which was approved on Dec. 14, 1895, 14 months later. In order to have local support and assistance the Cataract Power & Conduit Company was organized in Buffalo by its most prominent citizens, which company has undertaken the duty of distributing within the city limits the power brought to the boundary by the Niagara Falls Power Company. The franchise of Dec. 2, 1895, required the Power Company within 90 days after its acceptance to file plans and specifications for its work, and further that on or before June 1, 1897, the company should be prepared to supply 10,000 horse-power to consumers within the city. One thousand horse-power was supplied by Dec. 1, 1896. It was deemed advisable in order to avoid failure and disappointment in operation to provide this limited amount first. So satisfactory have the results been, however, that 25,000 additional horse-power are about to be developed by the Niagara Falls Power Company, and as much as desired delivered to Buffalo. The contract for the extension of the wheel-pit sufficient to develop 50,000 electrical horse-power was made in May, 1896, and will be completed by May, 1897. In respect to the rights of the Niagara Power Company on the Canadian side, Mr. Stetson said that the Province of Ontario had granted terms which were somewhat more favorable to the company than those conceded by the State of New York. The Canadian Niagara Power Company is under agreement to pay the Province an annual rental of $25,000, which rental secures to the company the right to place its works inconspicuously within the limits of the public reservation and so near to the Falls as to avoid more than 6000 feet of tunnel, which on the New York side had to be constructed at a cost of nearly $600,000, to bring the power-house of the company above the limits of the State reservation. The interest on the additional construction required in the State of New York was more than equal to the entire rental paid to the Province of Ontario. The promoters of the use of Niagara Falls power and its electrical transmission feel that not improperly they may presume themselves in some degree to be working for the public benefit as well as for legitimate personal profit. The Cataract Power & Conduit Company hopes and believes that an extensive and continual use of the Niagara power in the City of Buffalo will not only result to the material and financial advantage of those now producing nearly 40,000 horse-power from steam engines, at a cost believed to be at least twice that of Niagara power, but will also relieve the city from the veil of smoke so often obscuring her charming aspect. Extended investigation by this company into the cost of steam-power from coal or from oil or from natural gas in the various cities of the world has convinced every one that nowhere has any great city such an advantage as that now opening to Buffalo through its introduction of Niagara power, and in sanguine expectation of such prosperity and profit which can result only from a service which shall be equally profitable and satisfactory to the city, the Cataract Power & Conduit Company bids welcome to the citizens of Buffalo and its Mayor.

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FRANCIS LYNDE STETSON.

Other toasts were: "Welcome to Buffalo," responded to by Mayor Jewett; "The Empire State," by Comptroller Roberts; "The City of

Buffalo," by Mr. Charles W. Goodyear; "Water Power," by Mr. Charles A. Pillsbury, of Minneapolis, Minn.

Mr. Nikola Tesla, who was the guest of honor, received a perfect ovation when he rose to respond to the toast "Electricity," again and again the hall resounding with enthusiastic applause.

Prof. Elihu Thomson made a felicitous address in which he referred to his discussion with Lord Kelvin in 1879, regarding the possibility of long distance transmission of Niagara power. They both agreed that it was feasible.

Mr. Charles F. Brush made a few brief impromptu remarks, and was followed by Mr. Charles R. Huntley, who confessed that at the first suggestion of the Niagara power transmission scheme he was a doubting Thomas. He had since, however, changed his opinion very materially.

Mr. H. H. Littell spoke for the Buffalo Street Railway Company. He stated that his company had found Niagara power entirely satisfactory, and that it now desired more of it.

The directors of the Cataract Power & Conduit Company, all of whom, excepting Mr. John Jacob Astor, were present, are as follows:

D. O. Mills, Francis Lynde Stetson, Edward D. Adams, John Jacob Astor, Edward A. Wickes, Daniel O'Day, George Urban, Jr., Charles R. Huntley and William B. Rankine.

Among the electrical men in attendance were:

E. G. Acheson, Charles F. Brush, Lemuel Bannister, C. A. Coffin, W. L. R, Emmet, Horatio A. Foster, Fred A. Gilbert, S. Dana Greene, E. J. Hall. Jr., S. M. Hamill, J. S. Humbird, W. J. Johnston, H. H. Littell, W. H. Lawrence, B. F. Miles, T. C. Martin, Frederic Nicholls, J. P. Ord, C. W. Price, E. W. Rice, Jr., Dr. Coleman Sellers, C. P. Steinmetz, H. G. Stott, L. B. Stillwell, Frank J. Sprague, Elihu Thomson, Nikola Tesla, Charles A. Terry, J. W. Tillinghast, J. G. White and H. M. Watson.

Among others who were present may be mentioned:

Ex-Postmaster-General W. S. Bissell, State Engineer John Bogart, State Comptroller J. A. Roberts, Engineer A. J. Porter, Tunnel Contractor S. M. Clement, Clement Herschel, P. H. Griffin, Frank W. Hawley Richard Hammond and R. K. Noye.

On a New Method of Delicate Suspension.

BY FRANK A. LAWS.

The object of this note is to bring to the attention of those engaged in physical work, especially in connection with electrical testing, a device due to Dr. W. H. Julius, of Amsterdam, by means of which the effects of mechanical disturbances upon delicately suspended systems may be eliminated.

Perhaps the greatest field of usefulness for this device is in connection with the delicate reflecting galvanometers used in testing, for the conditions under which it is necessary to use them are often unavoidably such that the greatest vexation and delay are caused by mechanical disturbances due to jar from machinery and heavy traffic in the streets.

The Rogers Laboratory, of the Massachusetts Institute of Technology, is situated at the corner of two streets through which there is an ever-increasing amount of heavy teaming, and on one of which electric cars are continually passing. The building rests on piles, and the section of the city where the laboratory is situated is entirely built upon made land.

Under these conditions we have been greatly annoyed, and much vexatious delay has been occasioned by mechanical and electrical disturbances, the former having been largely remedied by the device now to be described.

The original papers by Dr. Julius are to be found in *Wiedemann's Annalen*, 1895, No. 56, page 151, and also in *Zeitschrift für Instrumentenkunde*, September, 1896, page 267. An English transcript is to be found in the *Electrical Review* (London), Oct. 23, 1896, page 519.

For the convenience of those to whom these periodicals are not readily accessible, a short description of the device, as we have constructed and used it at the Rogers Laboratory, will be given.

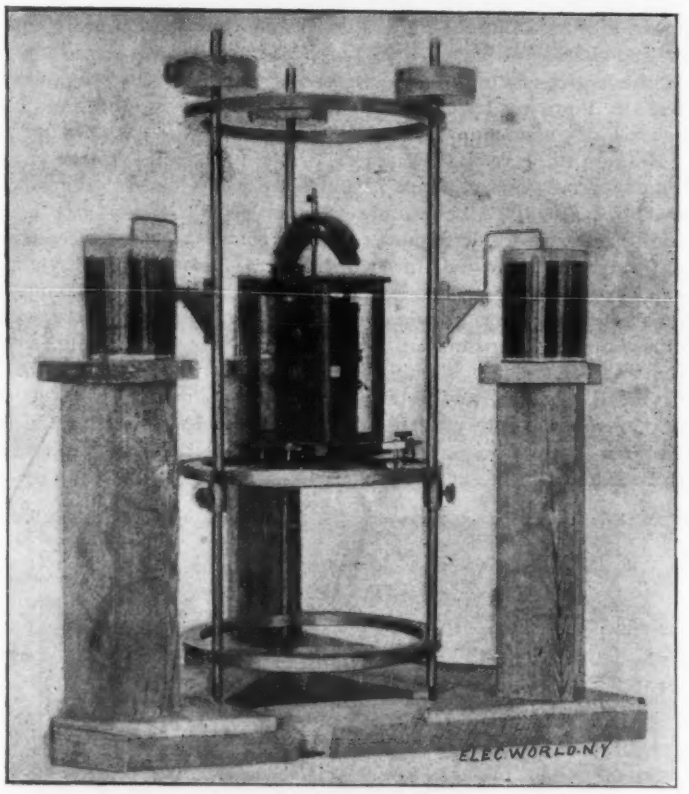
The cut shows the appearance of the device when in use. The arrangement consists of two brass rings 13 inches in diameter, one inch wide and one-half inch thick, held 24 inches apart by three brass rods one-half inch diameter, 30 inches long, which project four inches above the upper and two inches below the lower ring; at their lower extremities are leveling screws. Between the rings is a movable platform, sliding on the rods upon which the galvanometer can be firmly clamped.

The arrangement is hung by three fine steel wires from a three-armed support attached by a single lag screw to a bracket fastened to the wall of the laboratory. The points of attachment of the three wires are three stout hooks fastened to the brass rods so that the neck of the hook is 8¼ inches below the upper ring. Attached to the hooks are damping vanes, 3 by 4 inches, dipping in three jars filled with kerosene; the centres of the vanes are at the height of the neck of the hooks. Above the upper ring are three weights of six pounds each, which slide on the rods and can be clamped at any desired height by thumb screws.

To make the necessary adjustments the device is leveled and the galvanometer put in position, leveled and firmly clamped in place. The axis of the suspended system should be in the vertical axis of the arrangement. The platform is then raised until the point of attachment of the suspension fibre to the frame of the galvanometer is in the plane passing through the necks of the hooks, and the platform is then clamped.

The whole device, galvanometer and all, is then hung by one of the hooks and the weights adjusted until it hangs truly horizontal; the three weights should be at equal distances from the upper ring. The three steel wires, of equal length, are now attached to the hooks and the leveling screws raised, leaving the arrangement suspended. It is well to attach the wires at their upper ends to short screws which pass loosely through the three arms of the support, and are provided with wing nuts above. By these the final leveling may be effected.

We have subjected the device to most severe tests. The first galvanometer tried upon it had a suspended system so badly balanced



Suspension Apparatus.

that it was impossible to work with it under ordinary laboratory conditions, even though it was supported on heavy stone blocks resting on hair felt. When the Julius device was used the effect of jarring was hardly perceptible, not more than 0.2 or 0.3 of a millimetre at the most, the scale being a metre distant.

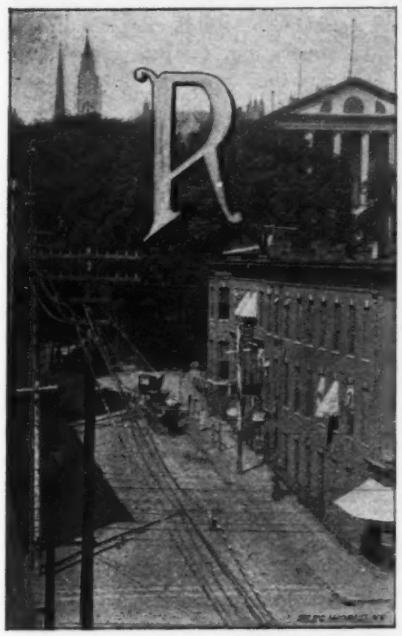
We next hung the arrangement (the same galvanometer being employed) from a plank placed on two step-ladders resting on the laboratory floor (frame). Under these exceptionally severe conditions it was possible to work with the galvanometer by choosing the time for observation.

The device has been permanently set up in connection with a ballistic galvanometer; it is attached to the wall of the laboratory, 70 feet distant from electric car tracks, over which there is an exceptionally heavy traffic. There is no perceptible disturbance of the needle due to jarring.

If care be taken in astaticizing the needle system of the galvanometer the device of Dr. Julius effectually solves the problem of doing satisfactory testing work in a laboratory situated in a busy city.

We are now engaged in applying this device to all our galvanometers.

The Richmond Telephone System.



RICHMOND, VA., has enjoyed a certain distinction in electrical matters since the first practical overhead trolley road was installed there 10 years ago. At that time it was the Mecca of curious railway men, anxious to believe and yet doubting the truth of the marvels that were told concerning the new motive power.

To-day the first metropolitan telephone exchange outside of the Bell Company's control is in operation there, having been quietly opened for business during the Summer of 1896. It has now in use about 1200 stations, with many more subscribers yet to be connected.

The construction of a telephone exchange in competition with an existing exchange is by no means an easy matter. The promoters of the new telephone company in Richmond were met at the outset with the difficulty of successfully rivaling a highly satisfactory and complete exchange operated by the Bell Company under the Law system. They also found the streets of the city occupied with a mass of telegraph, telephone, electric light, fire alarm and street railway wires which added a very great and apparently insuperable difficulty to the work of overhead construction. At the same time this was rendered no more easy by the orders of the municipal authorities which restricted the trunk lines where they were placed in streets to those already occupied by poles and wires.

In a large measure alleys were chosen by the new company, and in many instances main lines were constructed across private property, poles having been set in back yards and a devious course pursued over the tops of such houses as possessed owners amenable to argument.

It had been decided at the outset to make this, in a sense, a model exchange. Full metallic circuits to all subscribers were regarded as essential to proper service, especially in view of contemplated future long-distance extensions, and to avoid all "cross talk," which has been such a noticeable and disagreeable feature of many inferior installations.

The metallic circuit system, using two wires from the exchange to each station, naturally requires a greater amount of wire than any other. The number of wires already in the streets and the height of the poles necessary to carry the new lines clear above them called for the use of a proportionately very large amount of cable. In placing these cables an excess of capacity of about 50 per cent. was allowed in each case to take care of the growth of the system—a provision which was soon found to be insufficient, however, as the successful operation of the first telephones installed brought at once a large increase in subscribers.

In view of the length of the cables and the number of circuits carried in them, "filled" paper insulated cables were adopted, the conductors being laid up in pairs twisted about each other. The lead sheathing being rather light, was covered with tape and painted as a protection against abrasion.

The cable-line construction is very solid, the cables hanging from three-eighths-inch steel wire ropes, which are passed over the tops of white cedar cross-arms. These cross-arms in order to support the great weight of the cables were made 4¼ inches square and

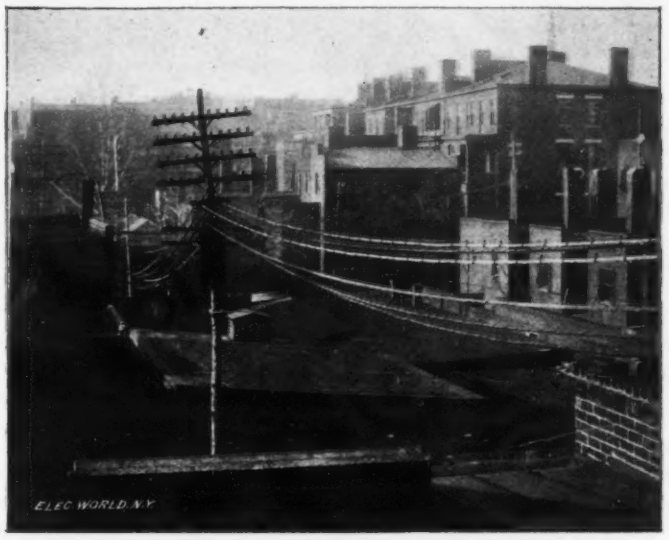


FIG. 2.—LINE CONSTRUCTION ACROSS BACK STREETS.

only 30 inches long, so that no cable could be supported more than 15 inches from the pole. They were additionally strengthened with stiff iron braces and heavily lagged to the pole. The cables are supported by wire ropes, which latter were passed over the tops of these arms, hauled taut and secured by a double service of No. 6 iron wire, well jointed to the support rope on each side of the cross-arm, around which the iron wire was wrapped two or three times. At about every eighth pole the wire rope was dead-ended, having several turns taken in it around the cross-arm. The solidity of this construction was demonstrated in the cyclone of Sept. 26, 1896, through which these lines passed without the loss of a single span of cable.

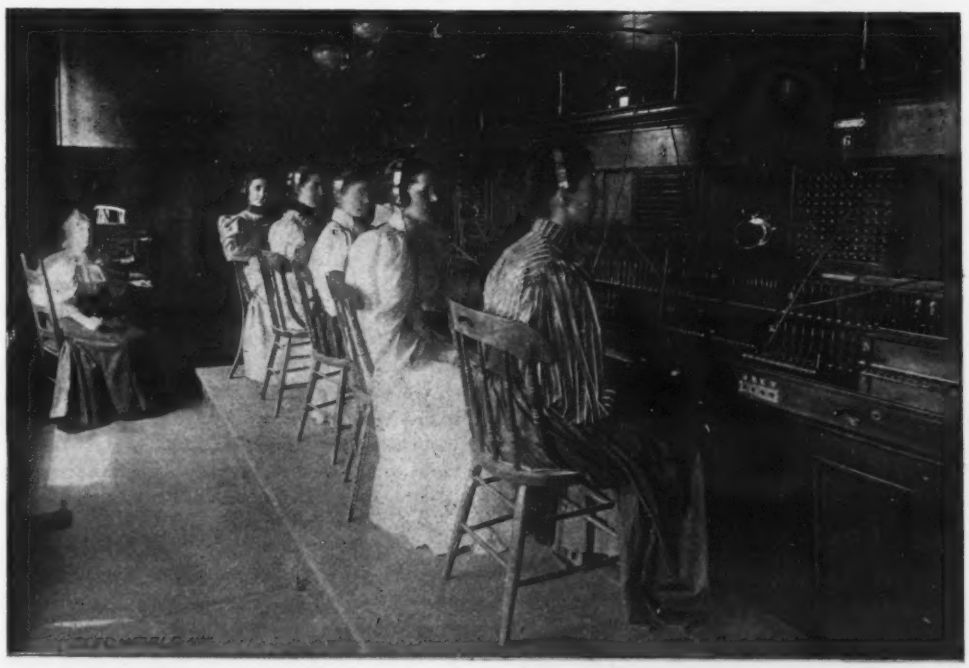


FIG. 1.—A PORTION OF THE SWITCHBOARD.

The great length of some of the cable circuits led to some fear that inductive troubles might be encountered. The satisfactory operation of the lines is in no small measure due to the excellent material supplied by the National Underground Cable Company and the Standard Underground Cable Company, who furnished the cables and hung them in position on the poles. The neat appearance of the lines is largely the result of the method of suspension used by the National Company, which is fully illustrated in the accompanying illustrations.

The poles used in the Richmond line construction were all of chestnut of native growth, cut from the standing tree. The limit of length imposed by the municipality was 35 feet. To carry the

lines through certain districts of the city it was necessary to use extremely high poles in order to avoid the maze of wires below, and in many instances, when crossing from back yard to back yard to clear intervening houses. The advantages of this alley and back lot construction have been demonstrated fully at Richmond, the lines being out of sight from the main streets, unobtrusive, the service entering to premises from the rear.

On account of the prevalence of sleet storms in Richmond, steel wire was selected for the lines, and about 2000 miles of No. 14 gauge put in place. This wire, of good quality and high tensile strength, has shown excellent staying qualities through both wind and sleet storms, while its higher resistance offers no obstacle to the powerful transmitters employed. Throughout the lines pony glass insulators are used, porcelain knobs of all kinds having been rigidly tabooed.

At the cable boxes the jumpers are twisted pairs of braided okonite of No. 16 gauge, secured to the pole and arms by small knobs. The pole boxes are made of pine covered with galvanized iron and having double doors. Reid terminal heads are used on all the cables, and the boxes also contain fuse and spark-gap lightning arresters for each wire.

The exchange equipment and telephones were supplied by the Western Telephone Construction Company, of Chicago. The transmitters are of the granular carbon type, having a high-wound induction coil and using two cells of Leclanche type battery. Their performance is superb, even under difficult conditions of resistance and leakage. The receivers are of the usual shape, but contain a bipolar (horse-shoe) magnet, the two poles being wound with coils in parallel, considerably increasing the loudness and sensitiveness of the receiver. Some very remarkable results were obtained in tests of these telephones during the installation of the plant. It was found that conversation was easily carried on through a circuit containing a lead-pencil mark six inches long, which had a resistance of about eight megohms. The tests for sensitiveness of receivers made before the adoption of the present type was by means of an induction balance arrangement.

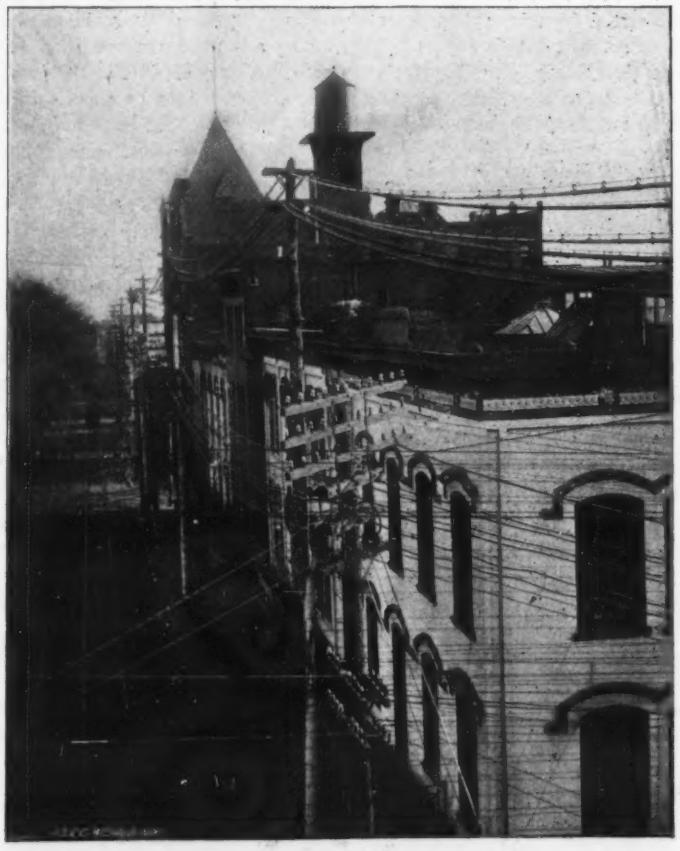


Fig. 3.—Cable Line Above Other Wires.

The use of these "long-distance" instruments at all the stations renders conversation over the lines extremely easy, especially so since the twisted pair cables seem to eliminate induction troubles. On the longer stretches of lines in surburban districts the two wires of each circuit are run on adjacent pins and transposed at intervals of about 1500 feet. The result is almost perfect freedom from extraneous noises on the talking circuits.

The exchange is comfortably and conveniently housed on the third floor of the *Times* Building, having a total floor space of 100 feet square. Here are located the operating, testing, repair and storage rooms and the business offices of the company. The cables,

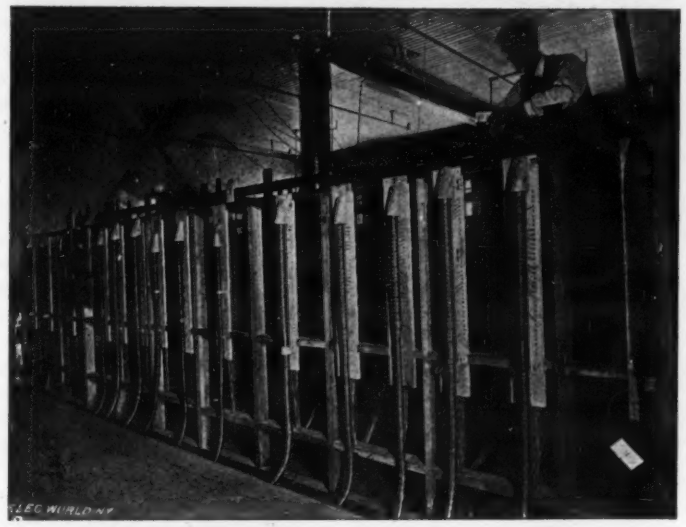


Fig. 4.—Cable Terminals at Back of Distributing Board.

38 in number, enter through a window and are carried in a conduit under the floor to the back of the distributing board. Here the terminals are instantly accessible for testing and cleaning. From them the circuits are led to the distributing board, a simple arrangement of troughs for the reception of the twisted pairs of wires, and thence to the lightning arresters. These are of the fusible strip pattern, having also a spark-gap and ground connection. The fuses are arranged to blow at 0.25 ampere, and several severe thunder storms during the Autumn demonstrated their efficiency in a very satisfactory manner.

The switchboard is of a new pattern, designed especially for this installation, and combines the advantages of the multiple board with great compactness, simplicity and facility of operation. It was necessary in this installation to provide for a considerable extension without accurate knowledge of how great this might prove to be The intercommunicating system adopted allows a practically indefinite extension without the complexity of the more usual multiple board of large size.

The board is built in sections of 300 drops each, permitting the addition of this number of new circuits at every time. In front of each operator is a case containing 100 spring jacks and drops. These are very compactly arranged in a space about 11 inches square. The frame of the case is of hard rubber divided into square cells, one for the spring jack and drop for each individual line. In the back of each cell is the electromagnet for operating the shutter. This is readily removable from the back of the board. The armature is pivoted at the front end of the coil and reaches back to its rear end, from which it is normally held by a slight leaf spring, which also serves to keep the armature from sticking. An arm integral with this armature reaches forward and engages the shutter, which is hung in the extreme front of the cell. Between the shutter and the electromagnet is placed the line spring jack, the springs of which are arranged to cut the magnet coil from the line circuit when a plug is inserted into the jack. When the shutter is thrown down by a call coming over the line it falls directly in front of its corresponding jack. The saving of labor resulting from this peculiar relation of the spring-jack and the line-drop is very great, as it is evident that the plug before entering the jack must pass the shutter, which it mechanically restores in so doing. In this way all the labor of restoring the drop is practically obviated, and when a shutter falls the location of the jack is apparent at once. The fact that the operator can plug directly at the drop which is down, and in so doing not only make the connection but at the same time restore the drop, greatly facilitates the rapidity of operation of this board. Each spring-jack is separately movable from the front of the board, while each drop-coil is separately removable from the rear of the board.

When a call is sent by a subscriber to central it is indicated to an operator by the falling of the drop of that subscriber's line. The operator on noticing this at once inserts a disengaged answering plug into the jack, thus mechanically restoring the drop, and making the initial connection with the calling line. By a slight movement of a circuit-changing lever she then connects her head telephone with the line of the subscriber calling, and finds out from him the number of the line with which he desires connection. If the line desired terminates in a jack on the board of the operator who answered the call or on either of the boards at her right or left, she completes the connection herself by inserting another plug in the proper jack. A slight movement of the same circuit-changing lever will then send calling current from a small alternator out on the lines of either one or the other of the subscribers so connected, thus ringing their bells. If, however, the subscriber called for is at a board not within the reach of the operator called, she presses a button in front of her which automatically connects her telephone with that of an operator who can reach the desired connection and instructs her to complete the connection. The first operator then sends calling current to the subscriber to be called in exactly the same manner as she did before. When a disconnection is desired by the subscribers, a signal is displayed to the operator who made the original connection, and she at once removes the plug and replaces it in its socket, directing the other operator to do likewise.

It is thus seen that instead of having one operator complete a connection between two subscribers, the work is usually divided up between two.

A very peculiar arrangement for intercommunication between the

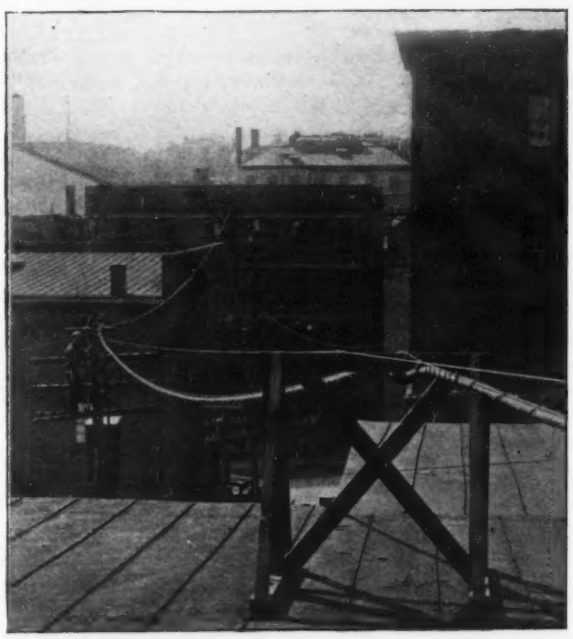


FIG. 5.—HOUSE-TOP LINE CONSTRUCTION.

operators is used. They are divided into what are termed districts or groups in such a manner that any particular operator can only communicate with about one third of the other operators instead of with all of them, thus greatly reducing the confusion on the construction circuits without in any way detracting from the speed of the system. In fact the districting system tends to increase its speed.

It will be noticed that no matter what the position on the board of the two subscribers to be connected, two and only two plugs are always used in making the connection between them. In transfer systems heretofore devised, three, four and six plugs have been used for accomplishing this same result.

The facility with which the operators are able to handle the various transfer connections after they have become thoroughly acquainted with the working of the exchange is surprising. A connection between two subscribers whose lines terminate at different ends of the switchboard is often completed within five seconds after receiving the call.

The cabinets in which these boards are mounted are extremely handsome in design and substantial in construction.

The new exchange has given great satisfaction to its patrons, and is rapidly extending its lines. It is contemplated in the near future to establish trunk-line connections with several points in Virginia and the Carolinas, and it is anticipated that there will be no difficulty in working the transmitters now in use over circuits up to 500 miles in length.

The company is a local institution, its officers and stockholders all being residents of the City of Richmond. John C. Robertson is president; S. C. Duvall, superintendent, and A. B. Guigon, general counsel. The construction was under the engineering supervision of C. T. Child.

It is gratifying to know that this first important attempt at the installation of a telephone exchange using other than Bell apparatus, despite many legal and physical obstacles, bids fair to result in both an operative and financial success.

A Reply to Observations by Mr. C. J. Reed Relative to the Carbon Electrode Battery.

BY D. TOMMASI.

I will reply briefly to the observations which Mr. Reed[1] has made upon the theory I have given for my carbon electrode cell.[2]

Mr. Reed claims that in this cell the evolution of electricity is solely due to the chemical action exerted by the solution of sodium chloride (NaCl), which serves as electrolyte, upon the lead peroxide (PbO_2) which surrounds only one of the two carbons which constitute the electrodes of my battery.

As for the other carbon (the one not covered with lead peroxide), it should not be attacked by the solution of sodium chloride in a closed circuit and should then behave as a simple electrical conductor.

This theory is inadmissible because it is contrary to experience.

In effect: First, In all voltaic couples in which a solution of sodium chloride is employed as the electrolyte, it is always the water which is decomposed and never the sodium chloride.[3]

Second, Lead peroxide (PbO_2) exerts no chemical action upon a solution of sodium chloride, even if concentrated.

These reservations made, let us admit for an instant that Mr. Reed's theory is true; that is, that the evolution of electricity in my cell is due exclusively to the action of sodium chloride upon lead peroxide;[4] then in this case it would be the carbon covered with lead peroxide which should become the negative electrode, since it is the seat of chemical action, whereas the other carbon, which, according to Mr. Reed, is not attacked, should form the positive electrode of the cell.[5]

Now precisely the contrary happens, since it is the carbon covered with lead peroxide that constitutes the positive pole and the carbon (without PbO_2) which forms the negative pole, that is to say, the soluble electrode, in my battery.

There is no doubt that the carbon should be attacked by the oxygen resulting from the decomposition of the water.

Practically the recent experiments of Dr. Coehn have clearly demonstrated that when a carbon anode is used in the electrolysis of acidulated water it is attacked with the formation of a mixture of carbonic acid and carbonic oxide (CO_2, 70 per cent.; CO, 30 per cent)[6]

I demonstrated myself some years ago that carbon combines electrolytically with oxygen.[7]

Why, then, does Mr. Reed find it strange that carbon constituting part of a voltaic couple can play the role of soluble electrode?

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[1] THE ELECTRICAL WORLD, Nov. 21, 1896, p. 620.

[2] THE ELECTRICAL WORLD, Nov. 7. 1896, p. 556.

[3] *Traité des piles Électriques*, Dr. D. Tommasi, p. 109.

[4] This supposition is inadmissible, for neither free chlorine nor the oxygen compounds of chlorine which would be formed in the decomposition of sodium chloride have any action upon lead peroxide.

[5] This takes place, to cite only one example, in the following cell: Negative electrode carbon; acidulated water; porous cup filled with copper oxide (Cu O); positive electrode carbon.

In this couple, the copper oxide is reduced to the metallic state. Now this action could not take place if the water were not decomposed by the carbon with formation of carbonic acid and carbonic oxide, whereas the hydrogen set free is carried toward the positive pole of the cell and reduces the copper oxide ($Cu\,O + 2H \quad Cu + H_2O$).

[6] If the E. M. F. of the carbon electrode cell is calculated from these data, it will be found that it is 0.7 volt, and this value is sensibly the same as that found by experiment (0.6 to 0.7 volt).

[7] *Traité théorique et pratique d'Électrochemie*, Dr. D. Tommasi, p. 513.

Conductor Resistance Met by Alternating Currents.

BY DUGALD C. JACKSON.

THE "skin effect" which causes a tendency on the part of alternating currents to seek the outer surface of a conductor of uniform resistance is a well known phenomenon, and a correction must sometimes be made, on account of the increased resistance caused by it in the computation of alternating current lines. But convenient approximate formulas for calculating the correction appear never to have been shown in simple form in American journals.

A distribution of current which is not uniform over the cross-section of a conductor results in the current meeting a greater resistance to its flow than it would meet were it uniformly distributed over the cross-section; and an increased fall of pressure and loss of power in the conductor therefore results. This increased fall of pressure is independent of the reactive (inductive) drop of pressure which may occur in an alternating-current circuit and which may be unaccompanied by a loss of power. The actual resistance met by an alternating current is therefore greater than the true resistance of the conductor through which the current flows. By true resistance is here meant the resistance defined according to the original intent of Ohm's law, $C = E/R$, where the current flow is steady and the

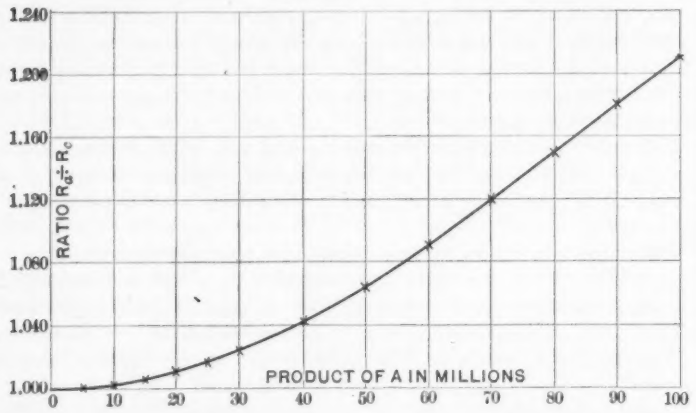


FIG. 1.—CURVE SHOWING CORRECTION FOR "SKIN EFFECT."

resistance is solely dependent upon the material, length, cross-section and temperature in the case of a homogeneous conductor. For want of a better name to distinguish the actual resistance met by the alternating current from the true resistance of the conductor I will call the former "consequent resistance," as it is consequent upon conditions outside of those relating to the conductor itself. The ratio of the "consequent resistance" to the true resistance, which theoretically is always greater than unity, may be easily computed to a close approximation for a conductor of circular cross-section, or wire, of non-magnetic material, by means of the following formula. In the formula

R_a is the 'consequent resistance," or resistance met by alternating currents, in ohms;

R_c the true resistance, or resistance met by a continuous current in the same conductor, in ohms;

f the frequency of the alternating current, and

l the length of the conductor in feet. Then

$$\frac{R_a}{R_c} = 1 + \frac{3.0}{10^{15}}\left(\frac{fl}{R_c}\right)^2 - \frac{7.5}{10^{30}}\left(\frac{fl}{R_c}\right)^4.$$

There are additional terms to this formula, but they are entirely negligible in practice. The formula corresponding to this when the length of the conductor is given in centimetres (l_c) is

$$\frac{R}{R_c} = 1 + \frac{1}{12}\left(\frac{2\pi f l_c}{10^9 R_c}\right)^2 - \frac{1}{180}\left(\frac{2\pi f l_c}{10^9 R_c}\right)^4 + \ldots.$$

By an oversight, this formula was allowed to slip into the text (page 147) of my book on "Alternating Currents and Alternating Current Machinery," in erroneous form. It is correct as shown above.

The first formula may be put into a more convenient form for use in many cases. If ρ stands for the resistance of a mil-foot of the wire, A for its cross-section in circular mils, and l for its length in feet, then

$$R_c = \frac{\rho l}{A}.$$

Substituting this value of R_c in the right hand member of the first equation gives

$$\frac{R_a}{R_c} = 1 + \frac{3.0}{10^{15}}\left(\frac{fA}{\rho}\right)^2 - \frac{7.5}{10^{30}}\left(\frac{fA}{\rho}\right)^4.$$

In the case of commercial copper wires, the resistance of a mil-foot (ρ) at ordinary temperatures may be taken at 10.6 ohms; so that for copper wires the formula becomes

$$\frac{R_a}{R_c} = 1 + \frac{27}{10^{18}}(fA)^2 - \frac{59}{10^{36}}(fA)^4.$$

In ordinary computations the last term may be neglected.

The last formula plainly shows that the magnitude of the "skin effect" is dependent on the product of the frequency of the alternating current by the cross-section of the conductor through which it flows.

The following example will serve to compare the results given by the formulas and illustrate their application. In the case of the first formula we must know the true resistance and length of our conductor and the frequency of the current. We will take 1000 feet of No. 0000 copper wire, the resistance of which at 70 degrees Fahr. may be taken to be .050 ohms. We will consider the current frequency to be 125. Then

$$\frac{R_a}{R_c} = 1 + 0.019 - 0.000 = 1.019.$$

In order to use the second formula we only need to know the frequency of the current and the cross-section of the wire in circular mils. The latter is 211,600. Then

$$\frac{R_a}{R_c} = 1 + 0.019 - 0.000 = 1.019.$$

It is seen that the last term of both formulas is practically negligible, and the best formula for ordinary use for values of fA not exceeding 60,000,000 becomes

$$\frac{R_a}{R_c} = 1 + \frac{27}{10^{18}}(fA)^2.$$

The values of the ratio R_a/R_c corresponding to different values of the product fA in the following table, and the curve in Fig. 1 were calculated from the formulas for copper wire. A similar table, apparently based on Mr. Mordey's computations, is given in Mr. Emmets's little book on alternating current wiring. There is no intention to give an impression by the table that the ratio is ordinarily required to be known to three decimal places, or four significant figures. Two decimals of the ratio are correctly given by the last form of the equation up to values of fA as great as 60,000,000.

TABLE showing the ratio of "consequent resistance" to true resistance in commercial wires at about 70 degrees Fahr., for various products of frequency and cross-section. The percentage differences of the resistances is shown by the decimal part of the ratio.

fA	R_a/R_c	fA	R_a/R_c
5,000,000	1.001	40,000,000	1.042
10,000,000	1.003	50,000,000	1.063
15,000,000	1.006	60,000,000	1.090
20,000,000	1.011	70,000,000	1.117
25,000,000	1.017	80,000,000	1.148
30,000,000	1.024	90,000,000	1.180
		100,000,000	1.210

The first two formulas given are applicable to wires made from any non-magnetic material, such as copper, brass, German silver, etc. The last two apply to copper only. To make these apply to any non-magnetic wire it is necessary to multiply the product fA by the ratio of the conductivities of the metals, thus

$$\frac{R_a}{R_c} = + \frac{27}{10^{18}}\left(\frac{k^1}{k} fA\right)^2$$

where k is the conductivity of commercial copper, and k^1 is the conductivity of the metal in the wire under consideration. The "skin effect therefore increases with the square of the conductivity.

It is interesting to note the way in which the magnitude of the "skin effect" is altered by the magnetic permeability when the conductor is of iron or other magnetic material. As the "skin effect' is caused by electromagnetic action, the magnetic permeability of the metal of the conductor enters the formulas in the same way as the electrical conductivity enters, but when the permeability is much greater than unity (its value for the non-magnetic materials) and

the frequency is within the ordinary commercial limits, the product of the values of frequency and permeability become quite large and a number of terms in the equation are required to get an approximate result. A new equation may therefore be used, which represents the condition when the product μf is large (μ being the magnetic permeability). This is

$$R_a = 10^{-5} \sqrt{10\,\pi\,\mu\,l\,f\,R_c}$$

The permeability of an iron or steel wire with respect to the circular lines of force set up in it by a current flowing through it

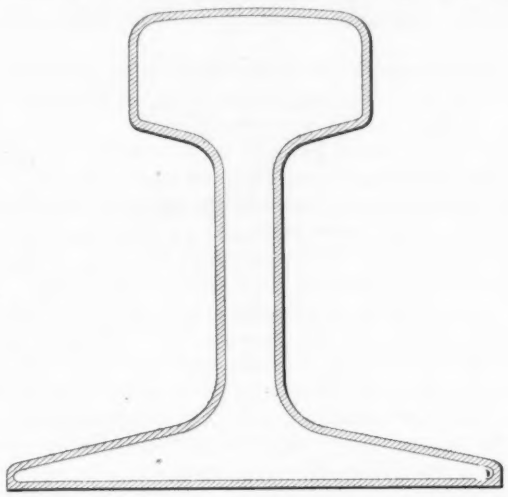


FIG. 2.—STANDARD SECTION 80-LB. STEEL RAIL, HALF SIZE.

has been variously valued between 150 and 300, according to the text books. Some experiments that Mr. Burgess carried out for me show that the permeability of a half-inch iron rod with respect to the lines of force set up by the current in it may be as great as 500 when the current is about 25 amperes.

It must be borne in mind that the formulas given above apply only to conductors with a circular cross-section. The ratio R_a/R_c is reduced when the conductor is flat or stranded.

There is an application of this which has apparently not been suggested before; that is, to the case of an alternating current electric railway circuit using a track return, such as is suggested from time to time as the ideal system of the future. In this case what may we assume to be the "consequent resistance" of the track? Andrew Gray shows that we may take the "consequent resistance" of an iron conductor carrying an alternating current to be no less than the true resistance of an outer shell of the conductor which has a thickness in mils which is approximately equal to $900\sqrt{\frac{\rho}{\mu f}}$. Supposing the frequency to be 25, the permeability to be 500, and the conductivity of Bessemer steel to be one-tenth that of copper ($\rho = 106$) then the thickness of this outer layer is 83 mils. In an 80-pound steel rail of the T-section shown in Fig. 2 there is a total cross-section of metal approximately equal to eight square inches; in the outer layers with a thickness of 83 mils, which is shown hatched, there is less than two square inches; and the "consequent resistance" of the rails in an electric railway track, under the conditions assumed, is therefore not less than four times their true resistance. Whether this large difference will be found in practice can only be determined by experiment, but it is certain that only a portion of the total conductivity of the track can be counted upon in case alternating currents are introduced in electric railway working where a track return is used.

German Push.

Our London contemporary, the *Electrical Review*, reprints the following unique specimen from a circular letter received from a German house (the italics are ours): "We have a pleasure in sending you a circular referring to a new invention. We shall feel very obliged if you will kindly let us know wether (*sic*) you feel inclined to take the invention up for exploitation, or if not, *which of your competitors would*, in your opinion, most likely *be able to do so?*'

An Advantage of Being a Toad.

In a 7000-volt alternating-current plant in France a short circuit arose, and on examination it was found that there was a toad between the terminals of one of the transformers, the curious fact being that the animal was not dead when found and was resuscitated.

The Use of Storage Batteries in Railway Work.

BY WM. BAXTER, JR.

(*Concluded from page 64.*)

In Figs. 4 and 5 is shown the arrangement that is generally adopted. In these figures it will be seen that the batteries are placed in parallel with the working circuit so that the station current can pass through one or both paths, according to the relation of the E. M. Fs. The battery and the station generator S supply toward the point P, and if the two E. M. Fs. at this point are equal there will be no current from the generator flowing through the battery. If the generator E. M. F. predominates the battery will be charged, and if not it will be discharged. Theoretically there should be a perfect balance at P, and any variation therefrom should cause a current to flow either in or out of the battery, but as a matter of fact in practice the difference between the two pressures must be 3 or 4 per cent. before any noticeable current passes in either direction. When the difference reaches 8 or 10 per cent. the current through the battery becomes very great, hence this arrangement, simple as it is, is thoroughly automatic and operates within a range

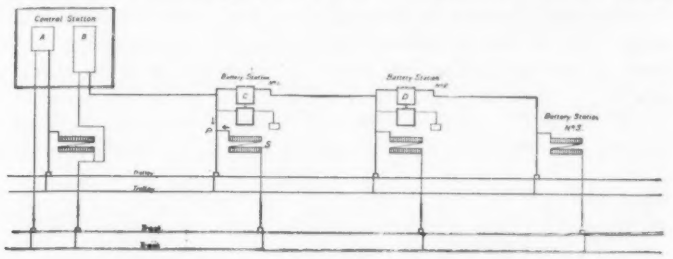


FIG. 4.

of variation that is wholly admissible for railway work. If the current from the generator B starts with an E. M. F. of say 550 volts and reaches the first battery at 500 it would reach the second battery at a still lower voltage, but if it is passed through a booster C, its E. M. F. can be raised so that it may reach the second station at the required pressure; the operation can be repeated as often as desired. There are many who believe that this method shown in Fig. 4 is the best one, but in reality it is not as good as that shown in Fig. 5. The loss of pressure in the transmission is what measures the efficiency, and it makes no difference whether this loss takes places at the starting point or at the end, and as it is more desirable to have the machinery located in the station than elsewhere, it follows that the best place to boost the current is in the station. There is still another advantage which might easily be overlooked, and that is that it requires power to operate the boosters, and if they are located along the line this power must be transmitted to them and wire must be provided for the purpose, but if they are in the station the wire that would be required for that purpose would be saved. In large plants, where a number of generators are used, it would be still better to feed the several batteries from independent

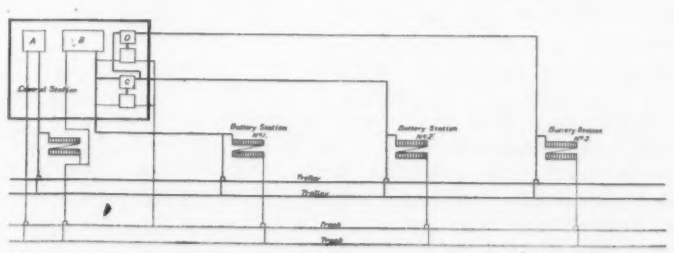


FIG. 5.

circuits, and use for each one a generator that would give the E. M. F. desired.

When batteries are used, as in these two figures, their capacity, as was stated in the opening paragraphs of this article, would have to be only a little greater than that of the battery located in the station. There would be no difference whatever if it were not for the fact that it is possible for the drain on any one battery to become at times greater than the maximum demand corresponding to it, as was stated in estimating the capacity of the batteries of the transformer method, shown in Fig. 2. This liability of the maximum load becoming abnormally great at any one point, can be provided for by an increase of the battery of not over 25 per cent., hence the cost thereof would not be more than $115,000 for the station capacity considered in the previous estimates. The cost of the line could be

greatly reduced, providing the carrying capacity is made sufficient to transmit the maximum current with a low drop when the batteries are located in the station, and in any case will cost much less for the same range of variation. This can be shown graphically as in Fig. 6. These diagrams are drawn to correspond with an arrangement in which the line is divided into four sections, with batteries located at the points indicated by the vertical lines 1, 2 and 3.

The middle diagram shows the amount of wire that would be required to deliver the average current from the station with a drop of 60 volts to the end of the line, the distribution being uniform throughout the entire length. The top diagram shows the amount of wire necessary to deliver the maximum current with the same drop. The blank portion shows the wire necessary to transmit the various amounts of current to the points where the batteries are located, and the shaded parts the wire required to convey the current from the lines to the points of utilization. In the top diagram each section has to carry 900 amperes, which is one quarter of the maximum current, but if batteries are located on the lines 1, 2 and 3, the current between them and the station can be kept constant and at a point equal to the average output instead of the maximum. From the batteries onward the wiring would have to be sufficient to take care of the maximum current, hence the wire required with the batteries located along the line would be as is shown in the lower diagram, in which the blank parts are the same as in the middle diagram, being of a capacity sufficient for the average current, and the shaded ones as in the top one, and of a capacity sufficient for the

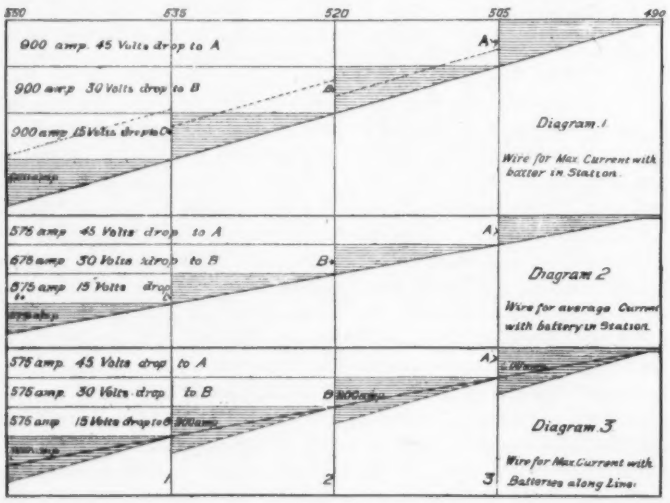

550
535
520
505
490
900 amp. 45 Volts drop to A
900 amp. 30 Volts drop to B
900 amp. 15 Volts drop to C
Diagram 1.
Wire for Max. Current with batter in Station.
575 amp. 45 Volts drop to A
575 amp. 30 Volts drop to B
575 amp. 15 Volts drop to C
Diagram 2
Wire for average Current with battery in Station.
575 amp. 45 Volts drop to A
575 amp. 30 Volts drop to B
575 amp. 15 Volts drop to C
300 amps.
Diagram 3
Wire for Max. Current with Batteries along Line.
1
2
3

Fig. 6.

maximum. From these diagrams it will be seen that the wire required with the batteries located along the line to keep the drop down to 60 volts with the maximum current is greater than that required to transmit the average current from the station, by the difference between the shaded portions of the top and middle diagrams.

The saving in wire in the case under consideration when the capacity is sufficient to keep the drop down to 60 volts with maximum current is about 38 per cent., the relation of the three diagrams being, with diagram 2 taken as unity, 1.14 for the bottom and 1.57 for the top, therefore the cost of wiring the batteries along the line having a capacity sufficiently large for the maximum demand is only 14 per cent. more than that required to provide for the average load direct from the station.

Applying these figures to the calculations recently made it will be seen that with the batteries located in the station and the line capacity sufficient to take the maximum current with a drop of 60 volts the cost would be increased beyond the figures already given by the difference between the middle and upper diagrams, which is 55 per cent. This would make the cost as follows:

For batteries	$93,000
For wire	706,000
Total	$799,000

The cost with the batteries located along the line and in parallel therewith would be as follows:

For batteries, 25 per cent. more than in the station battery arrangement for the reasons already explained	$115,000
For wire, 14 per cent. more than amount required for transmission of average current from the station	513,000
Total	$628,000

The saving therefore for the same service in both cases is about $170,000.

In the first calculations with the battery in the station, the line was figured for a capacity sufficient to transmit the average current with a drop of 60 volts and the cost was made out to be $543,000, but to provide for the maximum current an additional expenditure must be made of over $250,000, but an increase of only $85,000 will be required if the batteries were located along the line. It will also be noticed that when the station battery method is provided with line capacity sufficient for the maximum load, it will cost more than the plan of locating transformer battery stations along the line, as the figures for this case were shown to be about $649,000, a saving of $150,000.

In all these calculations the maximum loss of pressure has been taken at 12 per cent.; that is, starting from the station with 550 volts, the lowest E. M. F. at any point would be 490. A greater variation could be tolerated, and is perhaps in the majority of cases, but if it is permissible with the batteries located in the station, so is it when they are located along the line. If the wire is sufficient to keep the drop down to 12 per cent. with the average current, it would be about 17 per cent. with the maximum, or nearly 94 volts, thus reducing the pressure at the lowest points to about 456 volts.

If the estimates were based upon a greater drop they would not prove so favorable for the systems in which the batteries are located along the line, but the difference would not be very great, and would only have the effect of rendering the arrangement shown in Figs. 4 and 5 the most economical over somewhat greater distances. In no case, however, could the station battery plan become the cheapest—that is, taking into account only the cost of the batteries and the wire. As the cost of the buildings in which the batteries are located must also be taken into consideration, a further reduction would be required to get down to the actual gain, but the reduction caused by cost of buildings would become less and less as the size of the plant is increased; hence for large installations the results here obtained would not be very far out of the way.

From all the foregoing it is evident that the most advantageous way in which to use batteries on short lines is to place them in parallel with the working circuit, but for long transmissions, the transformer system will prove the most economical. It is not possible to say where the dividing line would come, since distance of transmission alone does not determine the question. A short line with very heavy traffic would be better adapted to the transformer system than a long one with light traffic. Again, the relative proportion of energy distributed at different points would materially change the results. In the calculations, here made, the distribution has been assumed to be uniform all along the route, but if the heaviest demand were nearest to the station, it would render the batteries in parallel with the line more advantageous than here shown, and a heavy distribution at the end of the line would have the contrary effect.

The advantage of the transformer method for long transmissions is due wholly to the fact that it is a means for utilizing high voltage, and as the weight of wire increases as the square of the distance when the loss of pressure remains constant, it is clear that very soon a distance is reached where the cost of line with the transmission at low E. M. F. becomes enormous, and it is at this point that the battery transformer comes in, because by the greatly increased pressure the reduction in cost of line can be made much greater than the difference in the battery capacity required.

It may be raised as an objection to this system that the practicability of generating large continuous currents of three or more thousand volts, has not been demonstrated, and that by some it is regarded as difficult if not impracticable; but as the current would be constant on account of the equalizing action of the batteries, the greatest difficulty, namely sparking on the commutator, would be removed, as the armature reaction would remain constant, and consequently the tendency for the brushes to arc across, which is the principal point of uncertainty, could more easily be counteracted. If it is not practical to generate large continuous currents of high E. M. F., the difficulty could be overcome by using a number of low E. M. F. machines in series, and finally, if this should not be regarded with favor, alternating current transmission could be resorted to, as it would only involve the use of the rotary transformers at the battery stations, which would not greatly increase the total cost of the installation, and in fact would reduce it below the figures here given, since it would be unquestionably practicable to use 5000 volts instead of 3000 as herein considered. If future experience should prove that it is possible to make constant current generators of large capacity and high voltage the system as here outlined could be used, but

should such generators fail to give satisfactory results, the system would still be available, in connection with alternating current generators. In addition to the saving in wire by the methods discussed in the foregoing, a further saving can be effected by locating the batteries with reference to the demands at different points. For example, if the points of greatest demand are as indicated by the sectioned profile at the bottom of Fig. 2, the third battery could be located on the line *A* and the fourth and fifth could be carried further forward. In this way a considerable saving could be made, as it requires much less wire to deliver say 500 amperes near the station and 100 a mile away than when the order of delivery is reversed.

Principles of Electrical Distribution.—V.

BY FRANCIS B. CROCKER.

INDIVIDUAL CONDUCTORS.

THE most certain way to obtain a constant voltage in parallel distribution is to provide each lamp or group of lamps with its own particular conductors. One arrangement of this kind is illustrated in Fig. 10, five groups of lamps, each taking 10 amperes and placed 200 feet apart, being assumed as in the previous examples. The feeding points, marked + and — are supposed to be located at some distance from the lamps, as shown. The pair of conductors that supply each group is so proportioned in size and length that the drop has an equal value for all of the groups. This condition will be secured if the cross-sections of the various conductors are respectively proportional to their lengths. For example, if a conductor is twice as long as another, it should have double the cross section, so that the resistances of the two will be equal. If the currents are not the same for the different conductors, the cross-sections should be further modified in proportion to the currents. In other words, for all of the pairs of conductors il/d should have the same value, i being the current in amperes, l the length and a the cross-section.

It is not apparent what advantage this plan of using individual

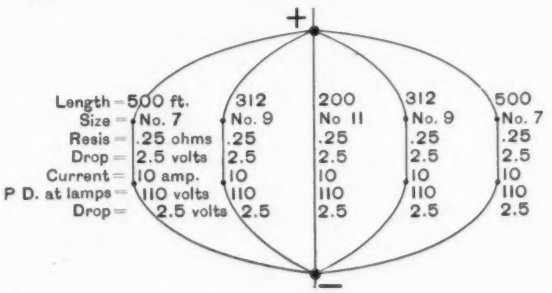


FIG. 10.—INDIVIDUAL CONDUCTORS. UNEQUAL LENGTHS; 186 LBS. COPPER; NO DIFFERENCE OF VOLTAGE BETWEEN LAMPS; 115 VOLTS BETWEEN FFEDING POINTS, + AND —; 5 VOLTS DROP.

wires has over the arrangements already described, the weight of copper being even greater than that in Fig. 7, for example. The answer is to be found in the fact that the groups of lamps in Fig. 10 are not only equal in potential when all are burning, but they are also independent of one another, the turning on or off of one or more groups not affecting the others, provided that the voltage at the feeding points + and — is kept constant. In the preceding cases, the throwing off of some lamps would vary the pressure of all the others. In fact, it was pointed out that disconnecting every lamp but one would raise its potential practically the whole amount of the drop, which was five or six volts in some instances. It was also stated that the remedy for this variation consists in regulating the pressure at the feeding points. Thus it appears that it is necessary to maintain a constant voltage at the feeding points with some arrangements of conductors and a variable voltage with others. These questions will be considered later under feeder regulation.

Fig. 11 represents another example of individual conductors, but in this case each group of lamps is supplied through the same total length of conductor, *i. e.*, 800 feet of No. 8 wire, having 0.5 ohm resistance. Consequently the drop is five volts for all, since each group takes 10 amperes. The advantage of this plan over that shown in Fig. 6, which it somewhat resembles, is the freedom from interference already explained. It should be noted, however, that in either Fig. 10 or 11 the turning off of a portion of the lamps in one particular cluster would affect the remaining ones in that group. In order to secure complete independence of operation for every lamp in a system, it would be necessary to provide each one with its own individual wires. This is practically out of the question in almost all cases, but it can be approximated more or less closely, the tendency in the best practice being to sub-divide the circuits and reduce the number of lamps on each, as far as economy and simplicity will reasonably allow.

Regulation of Pressure.—The feeding points in the various diagrams might in some cases be supplied with current directly from the generator, the voltage of the latter being varied in accordance with the number of lamps connected. With the arrangement shown in Figs. 4 and 5 it would not be necessary to alter the potential at all, because no lamp could receive more than 111 volts, which is the pressure at the feeding points, even if all but one lamp were turned off. The large amount of copper used in these cases saves the trouble of regulation, and often might be worth the extra first cost. This is practically the way that the majority of isolated plants are operated, the size of the wires being sufficient to limit the

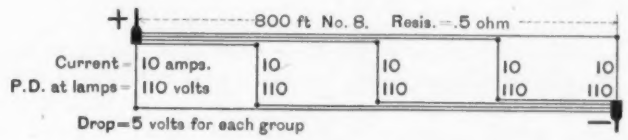


FIG. 11.—INDIVIDUAL CONDUCTORS; EQUAL TOTAL LENGTHS; 200 LBS. COPPER; NO DIFFERENCE OF VOLTAGE BETWEEN LAMPS; 115 VOLTS BETWEEN FEEDING POINTS + AND —; 5 VOLTS DROP.

drop to a small amount, so that the dynamos can run at a fixed voltage. As a matter of fact, however, the percentage of drop is usually too great to make this a very satisfactory method. If, for example, the wiring is designed for 5 per cent. drop at full load, and the dynamo generates 115 volts, the lamps will then be supplied with the normal pressure of 110 volts. But when nearly all of the lamps are disconnected, the remaining ones may receive nearly 115 volts which would rapidly destroy them, besides causing disagreeable fluctuations in candle-power. As a compromise, the dynamo might be run at 112.5 volts, but at full load this would cause the lamps to burn quite dimly, when the greatest light is required. The natural tendency to operate incandescent lighting plants at an average voltage is largely responsible for the poor illumination that is often observed, the lamp filaments being usually a dull yellow, and sometimes only red. But it is a false economy to prolong the life of the lamps at the expense of light. An increase of 10 per cent. in light for 500 hours is worth 50 cents at ordinary central station rates, which is enough to buy two new lamps. In other words, the electrical energy costs one cent per hour and the lamp only about $\frac{55}{500} = \frac{1}{10}$ cent per hour, hence it is very unwise to save the latter at the expense of the former. Furthermore, lamps tend to deteriorate in efficiency and give less light after a certain time. In short, for several reasons it is unwise to run them below their full rated voltage. These difficulties may be avoided either by regulating the generator by hand or by employing an "over compound" dynamo designed to automatically increase its voltage by an amount equal to the percentage of drop at full load.

With any of the arrangements represented in Figs. 6, 7, 8 and 9 the regulation of the generator would be practically necessary, since the potential at the feeding points is 115 volts or more at full load, which would be excessive at light loads. But by increasing the size

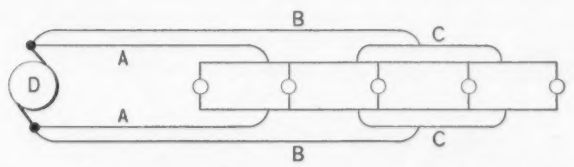


FIG. 12.—ARRANGEMENT OF FEEDERS.

of the conductors the drop can be reduced to a small amount, say 2 per cent. or less, so that it is not required to vary the feeding voltage. This applies not only to these cases, but to almost any possible system, demanding, however, a large quantity of copper.

The individual conductors, shown in Figs. 10 and 11, do not involve any regulation of pressure, the feeding points being maintained constantly at 115 volts, and each group of lamps always receiving 110 volts when it is turned on.

Feeders.—In almost all practical systems the feeding points indicated in the diagrams are at some distance from the generator, being connected to it by conductors which are called "feeders." These

are quite simple since they are laid in as direct a path as possible, and do not usually have any branches or lamps connected to them, being represented by the feeders *A A* in Fig. 12. Occasionally they are divided at the end like the feeders *BB* into two or more branches *C C* which lead to distributed points on the mains in order to equalize the pressure more perfectly. The portions *CC* are commonly called *sub-feeders.*

Feeder Regulation.—It has been shown that it is generally necessary to regulate the voltage at the feeding points to make up for the variable drop on the mains. When feeders are employed the regulation of the potential at the generator should be sufficient to compensate for the drop on the feeders also. If there is only one pair of feeders, or if they are all uniformly loaded, over-compound winding on the dynamo can be made to neutralize the total drop. But where there are several feeders which are differently loaded, it becomes necessary to provide some means for controlling them independently.

The various devices employed for this purpose are:

1. Feeder rheostats; 2. Auxiliary "bus-bars," and 3. "Boosters."

The first of these methods consists simply in placing a rheostat or variable resistance in series with each feeder, as represented in Fig. 13, the current capacity of the rheostat being sufficient for the maximum current conveyed by the feeder. In operating such a system a certain amount of resistance *R* is introduced into the circuit of a feeder *S* that is lightly loaded in order that the pressure which it supplies to the mains shall not be too high compared with that of the more heavily loaded feeder *B*, which has less resistance inserted. Thus by adjusting the arms of the rheostats *R* and *S*, the voltage at the ends of the feeders *A* and *B* may be made equal for all loads, or the potential at the end *B* may be raised a little above that of *A* in order to make up for the greater drop in the mains at *H* than at *F*.

The voltage at the further ends of the feeders may be determined by running an extra conductor *W*, called a "pressure wire," from

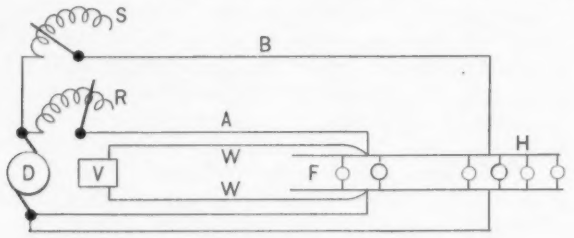


Fig. 13.—Feeder Regulation by Resistance.

the generating plant to the point at which the feeder is connected to the mains. The actual potential is read directly on the voltmeter *V*, since the current in the wires *W W* is so little that there is no appreciable drop upon them even when they are quite small. Another method consists in subtracting the drop *C R* on the feeders from the voltage *V* at the generators, that is, the potential at the ends of the feeders *P* = *V* — *C R*, in which *C* is the current and *R* the resistance of a given pair of feeders. For this purpose an ampere-meter may be put in series with each pair of feeders, and it could be calibrated to give the drop upon them by simply multiplying its scale numbers by the total resistance of the two feeders. A still more perfect device is the so-called compensated voltmeter. This has the ordinary coil which measures the voltage of the generators, and also an additional coil that carries a certain fraction of the feeder current, the effect of the latter being to modify the deflections of the pointer, so that it indicates the pressure at the far end of the feeder.

(To be continued.)

On the Use of High-Voltage Lamps.

In a recent communication to the London *Electrical Engineer*, Mr. G. L. Addenbrooke states that unless an entirely new lamp makes its appearance, the voltage of about 250 will be the limit for some time to come. With nearly 500 volts between on a three-wire system, the limit of safety is, under present conditions, about reached. The extra precautions necessitated by going above 500 volts would go a good way toward discounting any further saving in the mains. Although no one would think of operating a lighting and railway system on the same generator, yet the use of 220-volt lamps will permit of using the same generators for both purposes, being connected to whichever service they were needed upon. He states that in many cases marked economy would be secured in this way if accumulators were used to a considerable extent in the lighting.

Alternating-Current Machinery.—II.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

Elementary Principles.

Every electric current has two characteristic properties, namely: direction and strength. Each of these characteristic properties may vary. The direction of a current flowing over a conductor is either from or toward any point of that conductor at any given instant. That is to say, it must be either positive or negative as regards direction. The strength of an electric current may vary in any manner whatsoever. A current which continues flowing in the

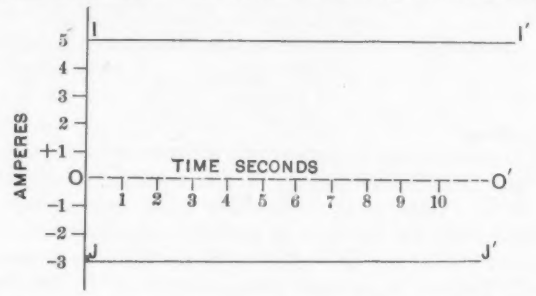


Fig. 5.—Diagram of an Unvarying Current of 5 Amperes Positive and 3 Amperes Negative.

same direction no matter how its strength may vary, is called a *continuous current*, or sometimes a *direct current.* A current which alternately flows in opposite directions, no matter how its strength may vary, is called an *alternating current.* In other words, the terms alternating and continuous apply only to the direction of a current, and not to its strength, or manner of variation in strength.

2. The simplest type of continuous current is that in which the strength is constant; such a current is called an *unvarying current.* It is graphically represented in Fig. 5. Here the line *O O'*, represents a zero line carried to the right uniformly with time, the point *O*, being the origin at a given instant of time, and the point *O'*, being reached, in this case, 10 seconds later. Ordinates above the line *O O'*, represent positive directions of the electric current, while ordinates below this line represent negative directions. Since a current produced by a difference of potential or electric level always flows from a point of higher to a point of lower potential, and since this is true in either a positively directed or negatively directed current, it is evident that the positive and negative directions may be arbitrarily assigned in each case. In Fig. 5 the current represented by the line *I I'*, is positive. The current begins at a strength of five amperes, and continues steadily at this value throughout the time *O O'*. Its trace *I I'*, in the diagram is there a straight line parallel to *O O'*. *J J'*, represents similarly an unvarying or uniformly continuous current of three amperes in the negative direction, or below the line *O O'*. This current would therefore flow through the circuit in the opposite direction to that of the current represented by the line *I I'*. Such unvarying currents are practically obtainable from primary or secondary

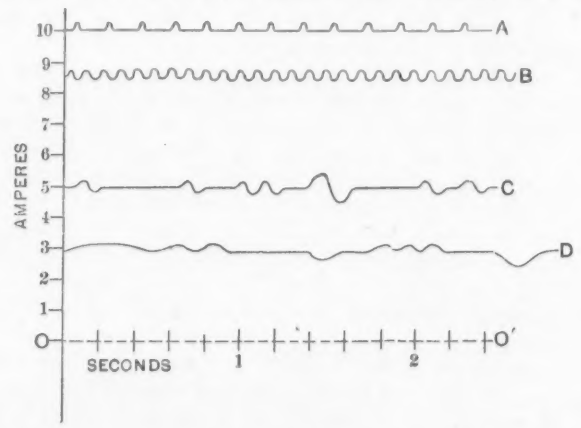


Fig. 6.—Diagram of Varying Unidirectional Currents.

voltaic cells, or from the so-called unipolar or commutatorless continuous-current dynamo. A continuous current which does not maintain a uniform strength is called a *varying continuous current*, the variation taking place either regularly or irregularly. A regularly varying current may be called a *pulsatory current.* Fig. 6, represents different forms of varying continuous currents. *A* and *B*, are

pulsatory currents, *C* and *D*, are *non-periodically varying currents*.

3. Alternating currents may be either *periodic* or *non-periodic*; in other words, the current may change its direction either at regular or at irregular intervals. Since the variations in the direction of alternating currents, as met with in practice take place at regular intervals, an alternating current is intended to mean a periodically alternating current, unless otherwise specified. Fig. 7, represents an alternating current which commences at four amperes positive, diminishes steadily to zero in one second of time, then increases to four amperes in the opposite or negative direction in the next second, then diminishes steadily to zero in the third second, and again increases to four amperes positive by the end of the fourth second. It is evident that this type of current is periodically alternating Fig. 8, represents a similar form of current of the non-periodic type. Here the current varies between five amperes positive and five amperes negative, and varies steadily from one value to the other, but the time occupied in making the successive changes is not uniform. Such a type of current is, probably, never met with in practice in such an exaggerated irregularity, but on the other hand a small deviation from perfect regularity of alternation in alternating currents frequently occurs.

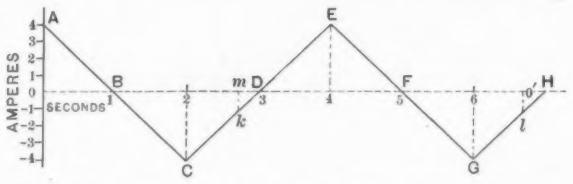


FIG. 7.—DIAGRAM OF PERIODIC ALTERNATING-CURRENT.

4. In the case of any periodically alternating current as, for example, that shown in Fig. 7, each successive positive or negative impulse of current is called an *alternation*, a *reversal* or a *semi-wave*. Thus *BCD*, *DEF*, or *EGH*, is an alternation. Two successive alternations constitute a *complete wave*, a *double alternation*, or a *cycle*. Thus *BCDEF*, or *DEFGH*, is a complete wave or cycle. Strictly speaking, a cycle need not commence at the zero point. It may commence at any point of the wave, but the cycle is in that case completed when the similar point is reached in the same direction on the next succeeding wave. Thus, in Fig 7, *CDEFG*, is a cycle. Here the cycle begins at the maximum negative value of the alternation *BCD*, and ends at the corresponding negative maximum of the next succeeding alternation in the same direction; namely, *F G H*, or, the cycle may begin at the point *k*, in the negative alternation *BCD*, and terminate at *l*, the corresponding point in the next similarly directed or negative alternation *F G H*, so that *k DEFG l*, is a cycle.

The time occupied in performing a cycle is called the *period*: thus in Fig. 7, the time occupied in performing any cycle is just four seconds. This is evidently true wherever the cycle may be assumed to begin. Thus between *A* and *E*, or between *O* and *H*, or between *k* and *l*, four seconds elapse. The number of periods executed by an alternating current in unit time is called its *periodicity* or *frequency*. When the time is not expressly mentioned, the second is usually understood, since the term frequency was defined by the Paris Electrical Congress of 1889 as the number of double alternations per second. Thus the frequency of an alternating current whose wave is graphically represented in Fig. 7, is one quarter of a period per second, or 15 periods per minute. The frequency is sometimes expressed in alternations or reversals per unit of time. In the case

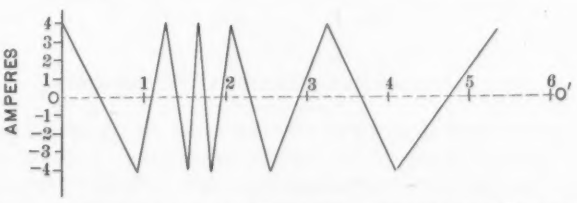


FIG. 8.—DIAGRAM OF NON-PERIODIC ALTERNATING-CURRENT.

of Fig. 7, the frequency is a half reversal, or half an alternation, per second, or 30 reversals per minute.

6. The terms cycle, frequency and double alternation are not employed in connection with non-periodic waves, and can only be so employed with restrictions. Thus in Fig. 8, the period of time, or the period of each cycle, varies from cycle to cycle as does also the frequency. The frequency and the period are mutually reciprocal quantities. Thus, a frequency of 100 cycles per second corresponds to a period of 1/100 second, and a frequency of 50 cycles per second corresp nds to a period of 1/50 second.

7. The frequency of commercial alternating currents varies between 25 cycles per second (3000 alternations per minute) and 140 cycles per second (16,800 alternations per minute.) In America the frequency of incandescent lighting alternating-current circuits is generally from 125 to 133 cycles per second, usually written (125 ∽ to 133 ∽), while the frequency of alternating-current circuits for arc lighting and power is usually about 60 ∽. In a few instances the frequency is as low as 25 ∽. In Europe the frequency of alternating-current circuits usually varies between 40 ∽ and 100 ∽.

8. All electric currents are produced by electromotive forces

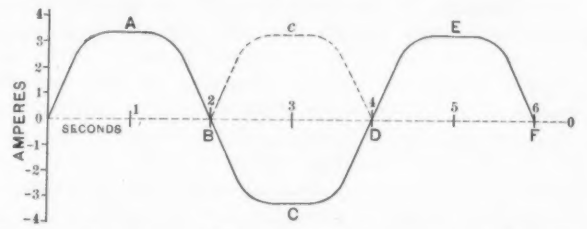


FIG. 9.—DIAGRAM OF SYMMETRICAL ALTERNATING-CURRENT.

(abbreviated E. M. Fs.), the character of the current being determined in every case by the character of the E. M. F. which produces it. Thus, a continuous current is produced by a continuous E. M. F., and an alternating current by an alternating E. M. F. Broadly speaking, when the resistance of a circuit remains constant, the type of current corresponds to the type of E. M. F., so that a pulsating current presupposes the action of a pulsatory E. M. F., and so on. Consequently, the preceding figures, 5 to 8, may be taken as representing E. M. Fs. of different types, expressed in volts positive or negative, instead of different types of currents expressed in amperes positive or negative.

9. In Fig. 7 the type of current strength variation is the simplest possible; namely, uniform increment and decrement to and from a maximum. Such currents, however, are not of the ordinary type. A periodic alternating current may vary in an infinitude of different ways. They may be divided into symmetrical and dissymmetrical types. A *symmetrical alternating current* is one in which each alternating semi-wave, when reversed in sign, exactly reduplicates the intervening waves. Thus, in Fig 9, *OABCDEF*, is the representation of a symmetrical alternating current, since if in the negative semi-waves *BCD*, each ordinate be reversed in sign so as to form the semi-wave *BcD*, the reversed wave will be the reduplication of the preceding semi-wave *OAB*. The contour *OA' B' C' D' E' F'*, Fig. 10, represents a periodic alternating current of the same frequency, but of dissymmetrical type, since the reversal of the negative wave *B' C' D'* does not reduplicate the preceeding semi-wave *OA' B'*. Practically all commercial alternating currents are of the symmetrical type. The dissymmetrical type is only met with occasionally in particular alternating-current apparatus, such as Ruhmkorff coils. It will be evident that, in the symmetrical alternating-current wave, the period is necessarily equally divided between the positive and

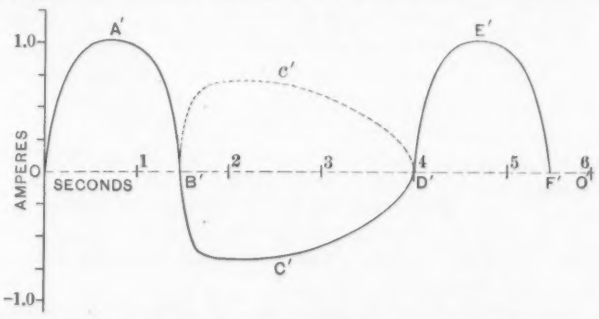


FIG. 10.—DIAGRAM OF DISSYMMETRICAL ALTERNATING-CURRENT.

negative waves, while this is not necessarily the case with dissymmetrical waves. Thus, in Fig. 9, *O B*, is equal to *B D*, or the semi-period embraces one alternation, while in Fig. 10, *OB'*, does not equal *B' D'*.

10. Confining our attention to symmetrical alternating-current waves, such as are practically employed, these may present an

infinite variety of forms. Fig. 7, represents the simplest manner in which such a current may vary, but as we have already seen, this type is not generally met with in practice. A very important type of variation is called *simple harmonic* or *simple periodic variation.* An E. M. F. or current which undergoes this variation is said to be a *simple harmonic* E. M. F. or current.

11. Simple-harmonic motions are very generally met with in natural phenomena. The motions constituting sound waves, light waves, and the vibrations of elastic bodies generally are simple harmonic motions. The apparent motion of a satellite in the plane of its orbit about its primary, when both are very distant, is practically a simple-harmonic motion. Thus the satellites of Jupiter have apparently a practically simple-harmonic motion. So, also is the motion of the bob of a long pendulum. The law governing a simple-harmonic motion of a particle is that the force acting on the particle is proportional to the distance of the particle from the mean or central point in its path, and is directed towards the central point. Thus a particle of a vibrating string performs a simple harmonic motion because the force urging it toward its normal position, or position of repose, varies directly with the distance of the particle from that point. If we attach a pencil to the bob of a long pendulum, and allow the pencil to lightly rest upon the plane horizontal surface of a sheet of paper, so as to trace a faint line to and fro over the surface of the paper, the motion of the pencil will be practically a simple-harmonic motion. An alternating E. M. F. or current which varies with time in accordance with the distance of the pencil point from the central point corresponding to the vertical position of the pendulum is called a simple-harmonic E. M. F. or current. Again the orthogonal projection upon a horizontal plane of a point rotating uniformly in a vertical plane, about a fixed horizontal axis, possesses a simple-harmonic motion. Thus, in Fig. 11, a disc AOB, rotates in a vertical plane uniformly counter clockwise, or in the direction of the arrows about the axis O. The vertically falling, or orthogonal, projection of P upon the horizontal surface aob, strikes this plane surface in the point p. The motion of p, between the limits a and b, corresponding to the positions A and B, of the rotating point is a simple-harmonic motion. Distances to the right of O, may be considered as positive distances, those to the left of O, as negative. A simple-harmonic E. M. F. or current will be one whose rate of variation corresponds to the motion of the point p. The rate of revolution of the disc corresponds to the frequency of the alternating current, so that a speed of 100 revolutions per second will produce a simple-harmonic motion of the point p, having frequency of 100 cycles per second.

The length oa, which is equal to the radius OP, of the moving point, is the *amplitude* of the harmonic motion. Consequently, the amplitude of a simple-harmonic or simple-periodic E. M. F. or current is its maximum cyclic value.

12. The phase of the point p, is a fraction of the periodic time varying between O and l. It is at any point the fraction of the period occupied in reaching that point from the position of maximum positive elongation. If, in Fig. 11, the angle AOP, is 60°, the point P, will have executed one sixth of the entire revolution in reaching it from OA, the horizontal positive radius, so that the phase of the point p will be 1/6. When the moving point next reaches the position p, the point P, will have reached the position P', and the phase will be 5/6. It is common, however, to express the phase as a fraction of 360°, so that the phase of p, is 60° at the position of OP and 300°, or — 60° at the position OP'.

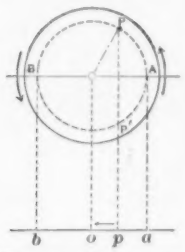


Fig. 11—Diagram of Simple Harmonic Motion.

13. When the moving point p, occupies the position o, the moving point p, will occupy a vertical position on the disc either above or below the centre. In the former case the phase angle is 90°, in the latter 90° or 270°. The difference in phase between the point in the position a and o, is manifestly 90°.

The phase affords a convenient means of defining the position of the point moving in a simple-harmonic manner, so that its position at any time during its cyclic motion may be expressed in terms of the phase.

By extension, the word phase is employed with a similar meaning in the case of alternating E. M. Fs. or currents which are not simply harmonic. Thus in Fig. 7, the phase of the current at the point marked A is 0°; at B, 90°; at C, 180°; at D, 270°, or — 90°; at F, 90°, and so on, the phase being measured along the axis OO', counting 360° to each period. Similarly the difference of phase of the current at the instants corresponding to the points A and C, is evidently 180°.

14. It is evident that the point p, in Fig. 11, while executing a simple-harmonic motion, leaves no trace of its successive instantaneous positions since it continues to trace and retrace the straight line $ab\ ba$. If, however, the paper be moved uniformly in the horizontal plane at right angles to the path ab, the moving point will trace a curve on the paper which is called a *sinusoid* or *curve of sines.* This is represented in Fig. 12. Here, a band of paper is moved steadily along the line OO', while the orthogonal projection to the rotating point P, carried on the disc $A\,B$, uniformly rotating in the vertical plane at right angles to OO', traces on it a sinusoid or sinusoidal curve. An alternating E. M. F. or current, which is simply periodic, or simply harmonic, is represented therefore by a sinusoidal curve, such as that in Fig. 12.

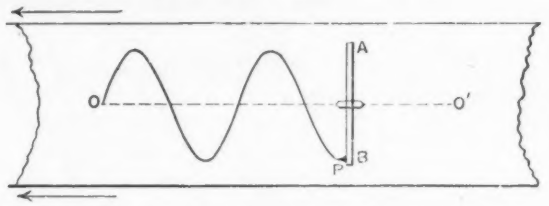


Fig. 12.—Diagram of Genesis of Sinusoidal Waves.

15. The sinusoidal type of E. M. F. or current is a single type out of the infinite number possible. It possesses, however, as we shall subsequently find, a number of remarkable properties which render it suitable for selection as the representative type of an alternating E. M F. or current.

16. We have thus far considered E. M. Fs. and currents which are not transient or temporary, but are maintained during the operation of an electric source. Similarly, types of E. M. Fs. and currents are found in particular cases where the electric source only acts for a brief interval of time. Such may be termed *temporary E. M. Fs.* and *currents.*

The following table represents an analysis of the various types of E. M. Fs. and currents which have been considered:

TABLE OF TYPES OF E. M. F. AND CURRENT.

E. M. F. or Current.	Sustained.	Unidirectional (continuous, or direct.)	Unvarying.		
			Varying.	Pulsatory or periodically varying.	Intermittent.
					Continually varying.
				Non-periodically varying.	
		Alternating.	Periodically alternating.	Symmetrical.	Simple-Harmonic or Sinusoidal
				Dissymmetrical.	
			Non-periodically alternating.		Non-Simple Harmonic.
	Temporary.	Unidirectional.	Uniformly increasing or diminishing.		
			Non-uniformly increasing or diminishing.		
		Alternating.	Periodically oscillatory		
			Non-periodically oscillatory.		

(To be continued.)

The Northwestern Electrical Association.

The fifth annual meeting of the Northwestern Electrical Association will be held at the Hotel Pfister, Milwaukee, Wis., on Jan. 20 and 21. The papers to be read on this occasion are as follows: "Incandescent Lamps," by F. S. Terry; "Protective Devices for Transformers," by H. C. Wirt; "Gaseous Fuel as a Means of Cheapening Electricity," by Nelson W. Perry; "Transformers," by O. M. Ash; "The Garfield Park Electrical Plant," by Foree Bain; "Röntgen Ray Phenomena," by Caryl D. Haskins; "Electrical Construction Affecting Insurance," by George S. McLaren; "Safety Devices for Electrical Circuits," by Prof. Wilbur M. Stine, and "Electrical Supplies," by W. W. Low.

Among the committee reports will be one on municipal ownership.

An Experiment Showing the Deflection of Cathode Rays by a Magnetic Field.

In a recent communication to the London *Electrician*, Prof. Fleming gives an account of an interesting experiment, showing the effect of a magnetic field upon cathode rays.

While attempting to produce, by means of a pear-shaped Crockes tube containing an aluminum cross, the effect described by Mr. Campbell Swinton lately [1] whereby a magnet pole placed at the end

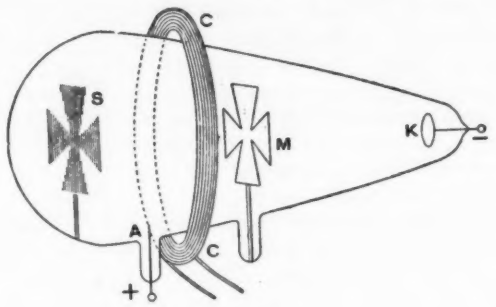


FIG. 1.

of the tube destroys in great part the green phosphorescence of the glass, and gathers the discharge into the axial line of the tube, it was noticed that another curious change took place at the same time, in the form of the shadow of the metal cross; and Mr. Morris and Mr. Clinton, who were experimenting with it, finally were led to try a coil traversed by current, placed round the tube as shown in Fig. 1, as a substitute for the magnet.

The following striking effects were then noticed. When the coil embraced that part of the vacuum tube between the metal cross and the end wall on which the shadow is formed, and when no current traversed the coil, the shadow of the cross was a dead black shadow on an apple-green phosphorescent ground, and was strictly the shadow of the cross defined by the cathode rays as in Fig. 2. When the embracing coil had a current passed through it the shadow rotated clockwise or the reverse, according to the direction of the coil current, and the arms of the shadow were a little distorted or twisted round, so as to resemble Fig. 3, the leading edge of the shadow being rather sharper than the trailing edge. Moreover, the shadow was altogether smaller than in the first case. As the current through the coil was increased the shadow cross twisted itself more round, and got still smaller, as in Fig. 4; and finally as the coil current was still more increased the cross shadow was further rotated and diminished until it vanished. At the same time the phosphorescent area on the end wall contracted, but as long as there was the smallest patch of green, a tiny little cross shadow could be seen in it. At this stage the coil current was increased still more, and a new and larger cross shadow made its appearance. This shadow was not so well defined, and the background less uniformly green;

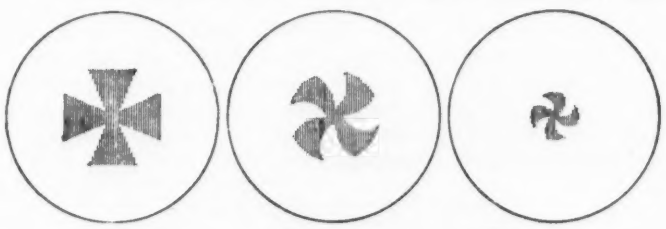


FIG. 2. FIG. 3. FIG. 4.

but it too, as the coil current was still more augmented, screwed itself round very slightly. The second shadow had arms more sickle shaped than the previous one.

If the magnetizing coil, instead of being placed to embrace the tube between the metal cross and the end wall farthest from the cathode, was placed over the portion in between the cathode and the metal cross, then the shadow went through the diminishing process, but *not* through the rotating and distorting phases, as the coil current was gradually increased step by step. In this case also there is a second stage in which a second and very much larger cross makes its appearance, which in turn contracts in size.

Any one possessing a vacuum tube of this kind, and a coil of a hundred turns or so, through which 10 or 12 amperes can be passed, can easily repeat this curious experiment. Prof. Fleming states that it is obviously due to the effect of the magnetic field upon the direction of the cathode rays on discharge. It is not difficult to see why, in the first case, the cross shadow rotates and diminishes; but the appearance of the second fainter and larger cross shadow seems to indicate that the effective radiant point of the cathode rays is moved nearer to the metal cross after a certain intensity of field is reached.

[1] THE ELECTRICAL WORLD, Aug. 1, 1896, p. 144.

Quick Work in Re-Establishing Destroyed Electric Light Service.

The destruction by fire on Dec. 29 last of the station of the People's Electric Light & Power Company, in Newark, N. J., left the city streets and many private establishments in absolute darkness. This unfortunate situation required some very active work on the part of the company in order to resume the service as speedily as possible.

The fire had hardly died out when Mr. Phillip N. Jackson, the president of the company, had put into execution his plans to secure new apparatus to replace that which was destroyed, and viewed alone from a physical standpoint, the resulting feat of buying, handling, shipping and setting up a lot of expensive, delicate and heavy machinery and getting it into operation in a short time probably stands unparalled.

The New York *Sun* of Jan. 10 gives a very complete account of Mr. Jackson's remarkable work. Realizing that quick action was necessary under the untoward circumstances, he at once called up by telephone the works of the Brush Electric Company in Cleveland.

The Brush shops were closed and the men had gone for the night and only the night watchman and firemen were around. The telephone operators then called up the residence of the general manager, S. M. Hamill. Mr. Hamill was in Boston. They called the assistant manager, Mr. Prentiss, in East Cleveland, who replied that he would look into the matter at once and telephone them. Mr. Prentiss then telephoned to Mr. Hamill at his hotel in Boston, 681 miles away. Mr. Hamill gave instructions to start the works at once, get out the men, secure cars from the railway and have them switched into the Brush shops and to load every available piece of electric apparatus and also to make arrangements with the Pennsylvania Railroad Company for a special train to run through direct from Cleveland to Newark. By midnight, and before the fire was out, this had been accomplished.

The dynamos weigh from 8000 to 10,000 pounds each. They were all loaded by an electric crane in the stock room on shop flat cars and transferred about 400 feet to another 10-ton electric crane, by which they were lifted into the freight cars. By daylight on Wednesday morning (Dec. 30) one half the cars were loaded, and at 3 o'clock in the afternoon 158,000 pounds of apparatus had been loaded in seven freight cars and started for Newark.

The public lighting service being thus provided for Mr. Jackson gave his attention next to replacing the incandescent plant. He called up the Stanley Electric Company, in Pittsfield, Mass., and at once closed arrangements for the immediate shipment from Pittsfield of six machines. It took four cars to carry them, and the loading was accomplished in just about the same time that it took to load cars with Brush dynamos at Cleveland, and the cars were started on the same day. The run from Cleveland was the longest and fastest. The special pulled in under the unloading crane in the Newark station at 12.05 Thursday noon, just 19 hours and 50 minutes after leaving Cleveland. Right behind the Cleveland train came the cars from Pittsfield.

In the mean time preparations had been made for placing the new apparatus. The ruins of part of the destroyed station had been sufficiently cleared, and it was found that one of the big engines could be used. New belts and other necessary appliances were hurriedly ordered, and a temporary roof was placed upon the building. The station, however, was not quite ready when the dynamos arrived at Newark, so it was decided to place some of them elsewhere. Two of the Brush machines were hauled into the station of the Central Power Company, which is owned by the People's Company. The floors were blocked up under them, and that night, 48 hours after the fire began, the dynamos were all connected with engines and wires, and were supplying 250 arc lights along the main parts of Market and Broad Streets. On Friday four more of the Brush machines were set up in the Boyd Street power-house of the Consolidated Traction Company beside the dynamos running the street cars, and 600 more lights were set glowing that night in other streets, in the parks and in Bloomfield, which is supplied with cur-

rent from Newark. That same day a Stanley machine was set up in a station in Mechanic Street, which belongs to the Company, and it put into use that night 4,000 incandescent lights in Newark, South Orange, Irvington and Clinton township. On Saturday the big belt for the Riverside engine in building No. 2 (one of those burned) was ready, and 13 Brush machines were set up in that room. Six of the machines were set running that night. The two other Stanley machines were set up on Saturday, and on Sunday night the entire system of wires had been reconnected with the new dynamos, and every part of the old service had been re-established.

Fifty thousand dollars' worth of machinery was thus bought and put into operation in so short a space of time that, under ordinary circumstances, it would hardly seem possible of accomplishment. The result of this remarkable feat reflects great credit upon all concerned and affords an excellent object lesson of what can be accomplished under stress of necessity.

Report of the Railroad Commissioners.

The fourteenth annual report of the Board of Railroad Commissioners of New York State contains much matter of general and special interest to street railway corporations.

The abolition of grade crossings, the Board states, is the most important pending legislative suggestion, and while the discussion of the subject relates to steam railway operation, it has a general bearing on electric railways. The Board is of the opinion that by the enactment of such a law better roads and quicker time will be some of the most important results—quicker time even than that of the Empire State Express.

Touching the subject of competition the report says, in part, that there is no need for another trunk line in this State at the present time. Laterals will gradually be extended into unoccupied territory, but this is a field particularly inviting to electric roads, and many such feeders to trunk lines are being built where there is public demand for railway facilities, but where the traffic does not warrant the construction and maintenance of a steam road.

The subject of lighting railway cars receives the Board's attention. The Board renews its former recommendations on this subject and believes that a law should be enacted requiring that all passenger coaches should be lighted by gas or electricity.

The latter part of the report is devoted specifically to street surface railways. The most serious operating difficulty with which the Board has had to deal during the past year has been in connection with street surface railways, particularly upon lines where, in order to handle heavy Sunday traffic without sufficient car accommodations, the extremely dangerous practice of overcrowding has been permitted.

The Board caused several investigations to be made where it believed these conditions existed, and it was found that not only was operation characterized by an utter disregard of a city ordinance regulating the number of passengers to be permitted upon a car, but also by non-observance of ordinary safety precautions and gross carelessness upon the part of employees.

Referring impliedly to the accident in Brooklyn last Summer, when two passengers were killed, the Board states that investigation showed that no effort was made by the city authorities either to enforce the ordinance above referred to or to prevent cars with both platforms and running-boards so crowded with passengers as to render it difficult for motormen and conductors to perform their duties, from running at a dangerously high rate of speed. In connection with these dangerous methods of operation, recommendations were made by the Board which, it was hoped, would if observed largely reduce the number of accidents upon street surface roads and some good results were obtained by their enforcement.

Courteous treatment of passengers by street railway employees, the Board thinks, should be exacted and practiced as much as it is on steam lines and the Board sees no reason why careless and dangerous methods of operation which would be regarded with horror on the latter should be tolerated on the former.

In the language of the report:

"The traveling public may be to blame for not reporting acts of insolence and discourtesy, but the companies can not plead ignorance of matters pertaining directly to the operation of their cars."

The Board recommends that section 36 of the Railroad Law relative to railways crossing each other at grade, be amended to make it positively applicable to street surface railways, and that there be a further provision empowering the Board, in its discretion, to compel railways having such crossings to put in an interlocking switch and signal device, the expenses connected therewith to be apportioned by the Board between the railway companies operating the tracks which cross each other.

In referring to the subject of fenders, the Board states that a thoroughly efficient fender does not seem to have been presented. Various kinds of fenders are in use, and in many instances the saving of life has resulted from such use. In some instances, however, the fender has been the direct cause of injury or death.

The use of power brakes on street surface cars operated by mechanical traction is still receiving attention at the hands of the majority of such roads. Although the necessity for such an appliance is conceded, no brake that will sufficiently answer the requirements has been obtained, say the Commissioners. Electric and air brakes have been experimented with and abandoned, other experiments are still progressing and street railway managers predict that in the near future all mechanically operated street cars in large cities will be equipped with power brakes.

The Board renews its recommendation to the Legislature that a law be passed requiring all street surface cars in the State to be heated during the Winter months. There is no longer any excuse for electric cars not being heated. There are also numerous devices upon the market for the heating of cable and other cars and many roads are properly equipped for this purpose. Legislation that would make the heating of cars compulsory would, the Board says, prevent much annoyance and inconvenience to the traveling public.

A table gives a comparative statement of the receipts and expenditures per passenger and the cost of operation per car mile on the principal street surface roads of the State.

The underground trolley system on Lenox Avenue, New York, is referred to under the head of "Motive Power Experiments in New York City." While not so satisfactory or economical as the overhead trolley, the report states, the system is regarded as preferable to the cable.

According to the report the experiments with compressed air motor cars have been satisfactory. After describing briefly the Hardie system, which is being tested on the 125th Street line, the Commissioners say that it is claimed by the inventor of the system that the cost of operation per car mile will be less than by the overhead trolley system. The limited operation on 125th Street, however, the Board states parenthetically, does not furnish sufficient data for accurate conclusions.

The Hoadley cars are operating on the Lenox Avenue line with apparent success, according to the report. In this system the power is applied by gearing, while in the Hardie system it is applied direct upon the axle.

The Manhattan Elevated Railway Company is preparing to make some experiments with the Hardie motor. A motor now being built will run on the Sixth Avenue line, between Rector Street and Fifty-eighth Street, and is designed to haul a train of five cars 13 miles without recharging. The engine will, it is expected, be ready for service some time in February.

Referring to the electric system being tested on the Thirty-fourth Street branch of the Elevated, the Board states that no difficulty in operation was experienced during snow storms, and mechanically the motor has done all the work required of it. The line, however, is too short and the traffic too limited, in the Commissioners' opinions, to admit of comparisons that would be of much value in determining the commercial efficiency of the system.

Polyphase Transmission of Power.

To the Editor of The Electrical World:

Sir:—In the serial on "Alternating-Current Machinery," begun in your issue of Jan. 2, 1897, occurs the following:

"It was not until the invention of the multiphase system of alternating current transmission, about the year 1888, that alternating current motors of any considerable size could be started from rest when connected to alternating mains."

This statement is vague and misleading. If it be intended to mean that polyphase transmission was invented about 1888, it is incorrect, since the very Gramme machine shown in the article is a polyphase machine. If, on the other hand, it be intended to refer to the commercial utilization of large self-starting polyphase motors, the date might safely be set several years later.

Pittsfield, Mass. John F. Kelly.

DIGEST OF CURRENT TECHNICAL ELECTRICAL ARTICLES COMPILED FROM FOREIGN AND AMERICAN JOURNALS

BY

CARL HERING

DYNAMOS, MOTORS AND TRANSFORMERS.

Pre-Determination of the Current for Three-Phase Motors. KUEBLER. *Elek. Zeit.*, Dec. 24.—A short article on the determination of the current of such motors when they are not loaded. Almost all of the theories which have been offered for induction motors, started with the assumption that the revolving field has a constant strength and a constant angular velocity, but this is not the case in practice; Raymond, in 1890, showed that the periodic changes in such a field are quite different than those required by theories which are based on the assumption that the magnetic field can be combined by the parallelogram of forces, like mechanical forces; the parallelogram method is strictly correct for the addition of sinusoidal changes and then has a mathematical but not physical significance; when used, it generally leads to a confusion of space and time; he therefore offers a method in which the graphical one is not used at all; it is described briefly in connection with an example. In any magnetic circuit containing iron, the M. M. F. force should also be calculated from the total ampere windings and without any reference as to whether the plane of the coil is at right angles with the axis of the magnet or inclined to the same; the inclination of a coil in a three-phase motor containing iron can therefore be neglected entirely, the ampere windings being simply added algebraically. The results obtained in his illustration differ materially from those obtained from the usual method of calculation; actual measurements show that this method gives results agreeing quite closely with those obtained in practice.

Design of a Bi-Polar Dynamo. STEELE. Lond. *Elec. Rev.*, Dec. 25.-A short communication referring to the recent articles by Kennedy and describing a modification in the method of calculating the field windings of a shunt machine. For a machine of a particular design and voltage one size of shunt wire will do and can be calculated by a quicker and more direct method, as follows: The ohms per 1000 feet are equal to the volts at the terminals of the shunt multiplied by 12,000 and divided by the mean length of a turn in inches times the total ampere turns required. The question of the weight of copper is far more important to the designer than that of the current density; the weight can be calculated quickly, as follows: The weight in pounds is equal to the square of the total ampere turns multiplied by the mean length of a turn in feet and by 3.15, this product being divided by the number of watts lost in all the field coils times 100,000.

Armature Reactions of Dynamo Machines. ROTHERT. Lond. *Elec. Rev.*, Dec. 25.—The beginning of a translation in full of the article which was abstracted in the *Digest*, Oct. 3. (See also *Digest*, Oct. 31, Nov. 28, Dec. 5 and 19.)

Mechanical Construction of Electrical Machinery. WEYMOUTH. Lond. *Elec. Eng.*, Jan. 1.—The first of a series of articles on the general principles involved in the mechanical construction of a dynamo, the present portion being on the bed plate.

Care of Electric Machinery. BAXTER. *Power*, January.—An article of a practical nature on armature troubles; he discusses the question of sparking, claiming that there is a "great deal of humbug in connection with the claims of spark experts," who claim to be able to locate at once any difficulty by simply looking at the brushes; he goes on to explain how armature troubles may be located.

LIGHTS AND LIGHTING.

Incandescent Lamp Question. GUSINDE. *Elek. Zeit.*, Dec. 24.—An article "On the Solution of the Incandescent Lamp Question" which consists largely of the rules and regulations which he formulated and which are adopted by the municipal station at Hanover, regarding the supplying, purchasing and testing of incandescent lamps; these rules and specifications are reproduced in full. The station supplies lamps to its consumers gratis if a lamp which was supplied by them fails, through any fault of the construction, or when the candle-power has fallen 20 per cent. of that marked on it; otherwise they are supplied for 12.5 cents when the old lamps are returned; any one who abuses these privileges will no longer be supplied with lamps from the station. The specifications for lamps which are purchased by that station are given and differ only in a few points from those which were recently suggested for universal adoption in Germany. Among the more important features are the following: Every lamp should be able to stand a variation of 2 per cent. above and any variation below the normal voltage, without injurious effects on the candle-power and consumption of energy or the relative life as defined in these specifications; a difference of $\pm$ 6 per cent. is allowed between the actual candle-power during the first 24 hours, and that marked on the lamp for its normal voltage; the candle-power is the mean between the values obtained on the photometer when the line joining the supports of the filament is perpendicular and when it is parallel to the axis of the photometer; the normal consumption of energy at the proper voltage is to be between 2.5 and 3.5 watts per candle; the consumption of energy during the first 24 hours may differ from the normal by at most + 6 per cent.; the relative life is to be the number of hours in which the candle power diminishes 20 per cent.; at the end of this relative life the actual consumption of energy at the normal voltage may be at most 25 per cent. greater than that marked on the lamp; the tests are to be made at the central station and are to be binding on both parties; from every batch of lamps a number of them up to 2 per cent. and at least five in number, will be taken at random for testing; at least 10 photometric measurements in each of the two directions will be made; if one of the lamps should break in the first 24 hours another will be taken to replace it and any that break after that and before the relative life test will be considered in placing the orders; if the conditions are not met by the lamps the batch of lamps is to be returned to the manufacturer at his cost; any lamps which are not in a condition to be used when received, and those which fail during the first 50 hours, are not to be paid for. Out of 26 manufacturers who were asked to bid under these specifications, seven, chiefly the smaller and less known manufacturers, made no offers; of the remaining 19 there were 13 that accepted all the conditions, while the remainder made objections to some of them, a brief summary of which is given in the article.—(The same issue contains a obituary notice of the author, Oswald Gusinde, Ph. D., who died on the 14th of December).

Mercury Arc. ARONS. *L'Eclairage Elec.*, Dec. 19; abstracted from *Wied. Ann.*, 58, page 73.—An illustrated description of the apparatus is given. Experiments with continuous currents of 110 volts gave the following results: Between five and nine amperes the fall of the potential is independent of the current, the arc being more unstable the longer it is; it can be increased from 10 to 60 cm in length and the voltage increases almost proportionally with the length, at the rate of 0.67 volts per cm, the current being 6.6 amperes. It seems that it is not correct to speak of the resistance of the arc in the sense used in Ohm's law. The temperature is higher than the boiling point of mercury at atmospheric pressure; with an external temperature of 200 degrees C. the arc may be maintained with 0.8 amperes and 20 volts; the phenomena are more interesting at higher voltages. The arc between mercury electrodes does not have properties which are essentially different from those of arcs between ordinary metallic electrodes; between potassium amalgam electrodes an arc is maintained at 10 volts; with Woods' alloy a fine light is produced, but the heat soon destroys the tube.

Progress in Arc Lighting. E. THOMSON. *Elec. Eng.*, Jan. 6.—A short article on the progress in the last fifteen years.

POWER.

Local Distribution in Workshops. E. K. SCOTT. Lond. *Elec. Eng.*, Jan. 1.—The first of a series of articles calling attention to the large field open for the economical application of electric transmission of power to isolated points comparatively near together.

Long-Distance Transmission. STEINMETZ. *Elec. Eng.*, Jan. 6.—A short general article on the present practice in long-distance transmission. Most of the plants now installed are either at 5000 or 6000 volts, fed directly from the generator, or for greater distances 10,000 volts with the use of step-up transformers; no plant of a higher voltage than about 12,000 appears to be in commercial operation in this country; distances of 35 miles have been covered by this voltage (at Fresno); 10,000 volts is far more reliable in its operation now than 1000 volts in the earlier days; it seems to be safe to use 10,000 volts in any climate, but with anything higher a consideration of the climate becomes necessary. Transmissions have developed in three fairly distinct directions—with a single generator and a synchronous motor for transmission of mechanical power; with a generator step-down transformers in such sub-stations for lighting and stationary motors; thirdly, for electric railroading; in the latter he refers to the transmission from Oregon City to Portland, describing the automatic method of controlling the phase relations.

Utilization of Niagara. RANKINE. *Elec. Eng.*, Jan. 6.—A short article stating what has been accomplished at present in the utilization of power at Niagara, the results of which are very encouraging; he adds a list of the present contracts for power, which amount to a total of 25,625 horse-power.

Electric Power on the B. & O. Fitzgerald. *Elec. Eng.*, Jan. 6.—A brief review of the gradual introduction of electric power on this road, giving, however, apparently nothing new.

TRACTION.

Possibilities of Primary Batteries for Motor Purposes. Peddie. Lond. *Elec. Rev.*, Jan. 1.—A short communication in which he attempts to calculate the possibilities of primary batteries for traction purposes, and comes to the conclusion that they cannot compete with secondary batteries where a supply of electricity for charging can be readily had, but he thinks the cost in the long run might be smaller with primary batteries, and they are much better in lasting power, but in any case the primary battery could be employed only where luxury and not economy was the aim.

Long Railway Lines. Short. *Elec. Eng.*, Jan. 6.—An article giving some practical suggestions for the operation of long lines. The greatest difficulty is encountered in the development of greater speed than is permitted within city limits, thereby increasing the variation in speed; for this reason he suggests using four smaller motors, one on each axle, so that when all are in parallel the speed may be 40 miles an hour, while when in series it is 10 miles an hour; there will then also be an increased tractive effort. The present trolley has reached its limiting current carrying capacity, and some improvement will be necessary for taking larger currents; he suggests two or more trolleys, one behind the other, or a single trolley making contact with two or three trolley wires. He thinks the trolley system impracticable for long distance, cross country roads, and recommends the third-rail system instead. He considers the use of alternating current motors imperative. In conclusion he makes the statement that the conversion of the energy of coal direct into electrical energy is already an accomplished fact, and that its application to the problems of street railway service is but a question of time; this would then supersede all the present electric railway systems.

Electric Traction Under Steam Railway Conditions. Henry. *Elec. Eng.*, Jan. 6.—A short article in which he refers to electric locomotives, favoring connecting rods driven from the centre, the use of six-wheel rigid frame trucks, the use of an induction motor on the centre axle, etc.; a few suggestions regarding the governing of engines are also given.

Madras. Guy. *Elec. Eng.*, Jan. 6.—A brief, illustrated description of this line in India.

Toledo.—Elec. Eng., Jan. 6.—An illustrated description of this combined lighting and railway power plant.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Central Stations in the United Kingdom.—Lond. *Elec.*, Jan. 1.—A large table published annually by that journal as a supplement, giving tabular data concerning the stations in London and the provinces, in operation and in progress. No general conclusions or summaries are given.

Lamp Connection Diagrams.—Lond. *Elec.*, Jan. 1.—A number of diagrams showing the lamp connections in the stations in London and the provinces; the total is a little over 3,000,000 8-cp lamps, which are divided almost equally between the alternating and the continuous current systems, slightly in favor of the former. 1,854,000 are connected to stations operated by companies and 1,210,000 to municipal stations.

Launceston.—Lond. *Elec. Rev.*, Jan. 1.—A long illustrated description of the lighting plant in this town in Tasmania, the most interesting feature of which was the way in which the difficulties in the erection of the plant were overcome, the generating station being at a water falls three miles from the town with no road leading to it.

Kensington Court.—Lond. *Elec. Eng.*, Jan. 1.—An illustrated description of a recent addition to this pioneer low-tension station in London.

Deptford. McDougall. Lond. *Elec. Eng.*, Jan. 1.—An abstract of a paper describing the operation of that pioneer high-voltage alternating station in London.

Three-Phase Plant at Dresden.—West. Elec., Jan. 9.—A translation in abstract of a portion of the article which was noticed in the *Digest*, Oct. 5, 1895, the original of which was abstracted in the *Digest*, Aug. 3 and Sept. 7, 1895; some of the curves of the waves are reproduced.

Central-Station Operation. Insull. *Elec. Eng.*, Jan. 6.—A short article on the development during the past 15 years.

Lighting and Transportation in London and Paris. Collis. *Elec. Rev.*, Jan. 6.—An abstract of an article from the New York *Sun*, being a statement of his recent observations.

Evolution of Isolated Plants. C. H. Davis. *Elec. Eng.*, Jan. 6.—The first portion of an illustrated article on their evolution during the past 15 years.

WIRES, WIRING AND CONDUITS.

Wiring Rules.—Lond. *Elec.*, Jan. 1.—A note giving the chief alterations in the fire insurance rules in Germany to adapt them to those adopted by the Union of Electricians in Germany.

Wire and Cable Manufacture. H. A. Reed. *Elec. Eng.*, Jan. 6.—An article on the improvement in wire and cable manufacture, with reference chiefly to the accomplishments of the Bishop Gutta Percha Works.

ELECTRO-PHYSICS AND MAGNETISM.

Use of Sine Curves in Alternating Current Problems. Rhodes. Lond. *Elec. Rev.*, Dec. 25.—He investigates mathematically the extent to which polar diagrams can be used and also the changes on vector representations produced by deviations from the simple sine law. Among his statements are the following: The virtual value of functions containing only odd harmonics, depends solely on the amplitudes of these harmonics and is independent of their phase positions. The virtual values of E. M. F. can be compounded with vectors whether they be sine functions or not. In order to see how polar diagrams are modified by taking hysteresis and eddy currents into account, the E. M. F. and currents may be considered as sine functions, provided the virtual values are taken to be the same as those possessed by the actual E. M. Fs. and currents measured by instruments following a square law; this is an extremely important and interesting result. As long as only virtual values are involved it is perfectly legitimate to base calculations on the assumption of the E. M. Fs. and currents being simply periodic; the vectors of hysteresis and eddy currents for instance can be calculated on the assumption of simple periodic values, but we cannot on the same assumption draw any conclusions respecting the amount of insulation which is effected by the maximum value. He discusses the effects of hysteresis and eddy currents on the polar diagram for an inductive current; he shows that the lag of the induction behind the current depends only on hysteresis; the lag of current behind the magnetizing force only on eddy currents; while the lag of the induction behind the magnetizing force depends on the combined effects of hysteresis and eddy currents.

New Method of Treating Alternating-Current Problems. Breslauer. *Elek. Zeit.*, Dec. 24.—A brief abstract of a recent paper in which he offers a method which is more exact theoretically and is better founded physically and mathematically than those heretofore used. Only a general idea of the theory is given; it was first offered by V. Dobrowolsky in 1891 at the International Congress of Electricians in Frankfort. (See The Electrical World, Oct. 10, 1891, page 268.)

Notes on Röntgen Rays. E. Thomson. Lond. *Elec.*, Jan. 1.—A short article containing the results of a number of observations. All the glass of the tube on one side of the plane through the platinum reflector is fluorescent, while the other is dark, the division being very sharp and the fluorescence remarkably uniform on the one side, showing that the intensity of radiation from that plate is sensibly the same whether the rays emanate normally or at an angle; for sharp focusing it is therefore best to use the rays which are almost in the plane of the plate. From this he concludes that the fluorescence of the glass is caused by and is an index of the intensity and distribution of the rays; sparks 1/8 inch long can be obtained from the outer surface of the bombarded spot; a screen made of finely powdered glass instead of the usual chemicals gave a feeble result, but sufficient to see the bones of the hand; it may be that the rays from the platinum are mixed with others of a lower wave length which can excite fluorescence like Röntgen rays, but are absorbed by the glass wall; that such rays can exist has been shown theoretically.

Röntgen Rays. Loth. *L'Eclairage Elec.*, Dec. 19; abstracted from *Wied. Ann.*, 58, page 344.—He shows that the chief radiation does not come from the whole region of fluorescence, but is limited to a spot close to the middle of the portion opposite the cathode. He studied the relative transparencies of 21 substances, including liquids, and found as a general result that the opacity increases with the density, but that there are exceptions to this rule, among the most striking of which are crystallized bodies, especially mica, feldspar and sulphate of copper; pulverized materials are less transparent than the same material in compact form; they are more transparent the more they are compressed; he thinks the differences arise from refractions and reflections from the surfaces of the particles.

X-Rays and Blindness. Walker. Lond. *Elec.*, Jan. 1.—An article against the sweeping denunciation of the proposal to make the blind see by means of X-rays. He argues that the senses are merely modes of motion; nature's method of conveying the sense of vision to the brain is only one way; any means by which light rays can be transmitted to the part of the brain allotted to vision and there perform the operation of stimulating the sense of vision, will actually give sight to a person; the full capabilities of X-rays are not yet known and it is not impossible to suppose that some form of such motion could be transmitted through the skull and brain and transformed into the form of motion that creates vision. An electric current passed from one temple to the other, when broken, produces the sensation of light. He adds that when a nerve has not actually been severed it usually can be restored by long, repeated applications of a very weak current.

X-Rays. Roiti. *Nuovo Cimento*, October.—An article in which he shows that the same tube can generate X-rays of different penetrating powers.

Mathematical Theory of Cathode Rays. Garbasso. Lond. *Elec.*, Jan. 1; noticed briefly from the *Nuovo Cimento*, October.—To test whether they are projected particles or waves of some kind, he inquires whether any continuous change of velocity of propagation is possible which would make the path of the rays a helicoidal curve, such as is actually observed when the rays are deflected by a magnet; he concludes that the vibration theory must in this instance give way before the more successful corpuscular theory.

Longitudinal Tension of Cathode Rays. COLARD. *L'Eclairage Elec.*, Dec. 26; abstracted from *Comptes Rendus*, 123, page 1059.—A mathematical article in which he shows that a cathode ray in a magnetic field behaves like a perfectly flexible conductor carrying the same current, and that there is in that conductor a longitudinal tension which is constant throughout the whole path.

Discharging Balls. PETROZZANI. Lond. *Elec.*, Jan. 1; noticed briefly from *Nuovo Cimento*, October.—He describes experiments with the discharge of a hollow brass ball suspended by various insulating rods, and shows that the worst thing to do if the charge is to be maintained, is to cover the glass rod with a layer of paraffin; the charge will be dissipated twice as fast as with a bare rod; ebonite is somewhat better than bare glass; varnished glass is the best insulator of all.

Tesla Experiments. VICENTINI and PACKER. Lond. *Elec.*, Jan. 1; noticed briefly from *Nuovo Cimento*, October —They describe some experiments made with large glass plates covered with tinfoil; also an instrument called a siren, operated by Tesla discharges and producing notes from a low pitch up to one transcending the limits of hearing.

Errors in Electromagnetism. VASCHY. *L'Eclairage Elec.*, Dec. 26; abstracted from *Comptes Rendus*, 113, page 1059.—He points out some errors in the usual assumptions regarding electromagnetism.

Electrification of Air. LORD KELVIN. Lond. *Elec. Rev.*, Jan. 1.—A brief summary of a recent paper read at the Royal Society of Edinburgh, on the electrification of air by Röntgen rays; he found that air electrified positively or negatively, lost its charge by the passage of Röntgen rays through it.

Physiological Effects of X-Rays. E. THOMSON. *Elec. Eng.*, Jan. 6.—A reply to the statement by Frei (see *Digest*, Jan. 2) in which it was claimed that no injurious effects were produced by X-rays generated by means of a static machine. Thomson states that the injury to his finger, which he described recently, was produced by a static machine with a half hour's exposure; the machine had a large output, comparable with a moderate-sized Ruhmkorff coil; he thinks it is merely a question of the size of the machine. He also corrects some statements which he was reported to have made; regarding the statement that the static machine is the most powerful exciter, he says that this depends on the size and capacity of the machine as compared with the other device for exciting the tube; he also made a statement that when the vacuum was very high the rays could easily penetrate very considerable thicknesses of iron.

Fluorescing Salts. EDISON. *Elec. Eng.*, Jan. 6.—An additional list of quite a number of chemicals which fluoresce under the action of the X-rays; they are all chemicals made at his laboratory, as those in commerce have already been tested and reported.

Static Machines for X-Ray Work. FREI. *Elec. Rev.*, Jan. 6.—A statement of the best methods of using such a machine for X-ray work; it is claimed that these machines give a clearer and sharper definition at a much lower cost for both apparatus and operation.

ELECTRO-CHEMISTRY AND BATTERIES.

Industrial Analysis of Copper. HOLLARD. *L'Eclairage Elec.*, Dec. 19 and 26; reprinted from *Comptes Rendus*, 123, page 1003.—A description of a short and complete method which he uses as chief of a laboratory in which many tests are made. The electrodes are a spiral and a truncated cone of platinum; a definite amount of copper is dissolved in sulphuric and nitric acid from which the antimony is then precipated, after which the solution is electrolyzed for two or three days; the deposit includes the silver also, as well as a portion of the lead, which is deposited as peroxide; the analysis of metallic impurities is described in the later issue.

Electrolytic Bleaching. SAGET. Lond. *Elec. Rev.*, Dec. 25; a short abstract of a paper in a French journal.—He describes a series of comparative investigations into the action on cellulose, of Hermite's solution of ordinary bleaching powder and of Gebauer-Knoeffler's solution; his experiments show that the same precautions are necessary with the electrolytic solutions as with ordinary chloride of lime solutions; as a bleaching agent the Hermite solution is the most active of the three.

Resistance of Electrolytes to Alternating Discharges. CARDANI. Lond. *Elec.*, Jan. 1; noticed briefly from *Nuovo Cimento*, October.—The principal conclusion arrived at is that electrolytes do not conduct such discharges through the surface layers as metallic conductors do, but evenly throughout their mass, that is, they obey Ohm's law, whatever the frequency of the oscillations, in which respect they differ decidedly from metallic conductors.

Working Metallic Sulphides. SIEMENS process. Lond. *Elec. Rev.*, Dec. 25.—A short note stating that as the sulphides and sulph-hydrates of the alkaline earth metals form double salts with the sulphides of antimony, arsenic and mercury, their lyes may be used for the extraction of these metals from their ores, from which they can be deposited by electrolysis without the use of a diaphragm; the whole of the lye is regenerated and the sulphur in the ore is converted into a useful form.

Electricity from Coal. CASE. *Elec. Eng.*, Jan. 6.—A brief summary, in chronological order, of all the effects to solve this problem which have come to his notice; the later ones have all been noticed in these columns.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Photographic Photometer. SIMON. *L'Eclairage Elec.*, Dec. 19; abstracted from *Wied. Ann.*, 59, page 91.—He argues that this is now an established method; it can also be used for photometry in the ultra violet spectrum, but there are objections; these, however, do not exist when the lights to be compared are homogeneous and when the comparison is made by finding the two photographic impressions which are alike. A brief description is given of the Zeiss method of comparing the intensities as shown by the photographic prints.

Liquid Damping for Mirror Galvanometers. JACOBS. Lond. *Elec. Rev.*, Dec. 25.—A brief illustrated description of a form of plug-tube for dead-beat galvanometers, by means of which the usual objections to liquid damping are overcome; the tube can be filled without immersion and will include a small amount of air, which is contained in a suitably provided space where it will not cause any inconvenience; the tube can then be completely sealed.

Variations in the E. M. F. of Clarke Cells with Temperature. AYRTON and COOPER. Lond. *Elec.*, Jan. 1.—A reprint, with the numerous curves, of the paper which was abstracted in the *Digest*, Oct. 17.

Compensating the Self-Induction in a Wattmeter. DANIELSON. *L'Eclairage Elec.*, Dec. 26.—A translation of the article which was noticed in the *Digest*, Dec. 5.

Localizing Faults in Submarine Cables. RYMER-JONES. Lond. *Elec. Rev.*, Jan. 1.—A descriptive article on tests made from one end of the cable only. He refers favorably to the Kennelly method and to the modifications described by Cann (see *Digest*, last week) and elicits from them certain interesting points which he has turned to practical use; he shows that instead of three tests and the use of Cann's formula, only two are necessary, as the third may be calculated from the difference between the two measured resistances, the relation of each to the third being a constant quantity; he gives the resulting modification of Cann's formula and enumerates the advantages secured by this simplification, among which are that the testing battery need be only half as great as with the Cann method and one eighth as with the Kennelly method; besides this the testing current is very small, for which reason an inconstant battery can be used and there is much less gas set free at the fault. A detailed description of the test with some examples to illustrate its application are given.

Apparatus for Illustrating Phase Difference. DERR. *Tech. Quart.*, December.—A brief description of an apparatus suited for lecture-room illustrations. A wire carrying the current is stretched perpendicularly across the magnetic field, and therefore has a force developed in it which moves it at right angles to both the direction of the field and the current; the wire is connected with a small mirror, which reflects a beam of light on a screen; a tuning pin is secured to the end of the wire so that the period of free vibration may be made to coincide with that of the current; the line of light which would be formed is drawn out into a curve by means of the usual revolving mirror, the result being a perfect sine curve when the wire is vibrated mechanically; with two such wires the phase difference between the two currents is easily shown by a horizontal displacement of the curves. The apparatus is illustrated together with a convenient three-point switch for changing the connections rapidly; with a current of one ampere and a distance of 30 feet, the amplitude of the curve will be two feet. The results are not quantitatively accurate within several per cent., especially if the currents are not truly sinusoidal, and the apparatus is therefore not fitted for precise measurements.

Electrical Measurements. ANTHONY. *Elec. Eng.*, Jan. 6.—A short article of a historical nature describing the development of electrical measuring instruments.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Communication Between Light Ships and the Coast. Lond. *Elec. Rev.*, Dec. 25.—An editorial article reviewing chiefly experiments made in this country. It states also that the latest recommendation of the Royal Commission has failed. Mr. Preece explained that the conductivity of sea water was too great, and failure was the consequence; the intervening sea-water performed about the same function as an iron plate, which interrupted the electric waves, and they therefore did not reach the ship. Up to the present time there is no single instance of a permanen establishment and use of the non-continuous or of the diffusion method.

Railway Signalling.—Lond. *Elec.*, Dec. 25, and *Elec. Rev.*, Jan. 1.—A brief description of the BOULT system, which is being tried on an English railway. In place of the semaphores and colored lights, there is a signaling apparatus on the engine itself, operated by a magnet on the road, which actuates a polarized mechanism on the engine; the magnet is moved from the signal box; the mechanism on the engine consists of two needles moved by the magnet and acting as relays.

Accumulators in Telegraphy. MONTPELLIER. *L'Elec.*, Dec. 19.—The first part of an illustrated description of the installation of accumulators at the central telegraph office in Paris; it is a new installation and is simpler than the one used heretofore. There are six batteries of 60 cells each, three for the positive and three for the negative currents, each battery having a capacity of 72 ampere-hours; the results have been very

satisfactory; these accumulators replace about 11,000 Callaud cells. A single positive and a single negative battery suffice for 24 hours, during which time one of the others is being charged, while the third, completely charged, is ready to be substituted at any time for the one in use. With each group there are three commutators, one for each battery; a complete illustrated description is given, they being rendered somewhat more complicated, as the dynamos for charging the batteries generate only 70 volts, necessitating the division of the battery into groups for charging.

Fire Alarm System.—Elek. Zeit., Dec. 24.—A conclusion of the long article describing and illustrating the electrical exhibits at the Berlin exhibition; the present one gives a brief illustrated description of the fire alarm system used at the exhibition.

Submarine Cablegraphy. Ward. *Elec. Eng.*, Jan. 6.—A short article describing the progress which has been made in the past 15 years, as exemplified by the conditions in the North Atlantic Ocean. The three main points in which it has made great strides are: That the facilities have been greatly increased; the rapidity, legibility and accuracy of transmission have been much improved by the use of better cables and perfected apparatus; the service has been cheapened. Fifteen years ago there was not a single cable coming direct to New York City, but now there are several, and it seems almost impossible that communication could ever be interrupted.

Telegraphy. Maver. *Elec. Eng.*, Jan. 6.—An article enumerating the most important developments in this field during the past 15 years.

Telephone Relays. Elec. Rev., Jan. 6.—A reprint of the note which was noticed in the *Digest*, Jan. 2.

Street Railway Signaling System.—Sc. Am., Jan. 2.—An illustrated description of the system used on the Broadway and Seventh Avenue Cable Railway in New York City, in which electrical communication is established between street signaling boxes and the power house.

Persian Gulf Cable of 1864. Webb. *West. Elec.*, Jan. 2 and 9.—A reprint of the article noticed in the *Digest*, Oct. 31.

Military Telegraph Line in Arizona. Elec. Eng., Dec. 30.—An illustrated description of the line from Bisbee to San Bernardina.

MISCELLANEOUS.

Effect of Electricity on Plants. Narkewitsch-Jodko. *Elek. Zeit.*, Dec. 17 and Lond. *Elec. Rev.*, Dec. 25.—A brief abstract from a St. Petersburg journal giving a summary of his researches which he has carried on for the past 20 years. There are two methods in which he applied electricity, one of them consisting in placing a copper and a zinc plate in the earth and connecting them above the ground by a wire, thus producing a galvanic cell; the second method, which he seems to prefer, consists in "leading off the atmospheric electricity in the earth"; both are very simple; the latter is done by means of wooden poles about 30 feet high, the tops of which contain nickel-plated copper needles, insulated from the pole and connected through four radial wires to as many zinc plates in the ground; 10 to 15 of these poles are sufficient for a hectare (2.5 acres); the cost per hectare is about $7.50. The action of the current in both methods is a double one; it acts chemically in dissolving the parts of the earth necessary for nourishing the plants, making it easier for them to obtain the nourishment; he adds that electro-culture can only be applied with advantage in rich soils and that in poor soils the action is detrimental; the second action is a mechanical one, as it is claimed that the particles of the electrified earth are set into molecular vibration, thus loosening the earth; that the electric current produces such an action was claimed to be shown by some photographs of dust particles on glass plates under the influence of weak currents. Another experiment showed the good conductivity of plants. The principal results obtained are shown in a table of data covering a period of three years, the experiments having been made with rye, oats, barley, potatoes and hemp, the figures giving the yield with and without electro-culture. Barley and potatoes at first gave negative results but it was shown that the "electro-cultivators" had been too numerous and when their number was reduced the yield was increased; (the average increase seems to be between 25 and 50 per cent., in some cases being nearly 100 per cent). The effect of the cultivators on fruit trees gave as good results.

In an editorial in the same issue of the German journal a brief review of the subject of electro-culture is given. Three kinds of applications of electricity have been made; in the first the development of flowers and fruits was assisted by exposing the plants at night and during foggy days to an electric arc light; in the second the property of the seeds to sprout was increased by subjecting the seeds, before planting, to an electric current; in the third method the yield of the plants is increased by passing an electric current through the plants while growing and through the earth around their roots. Results of experiments leave no doubt that the action is beneficial; the only doubt is whether such an application of electricity is profitable commercially. Hastening the ripening of fruits by means of the arc light was accomplished by Sir Wm. Siemens as shown in his Royal Society paper in 1880; an arc light of 1400 candles at about two metres has the same action on plants as daylight; he also showed that plants do not require a time of rest and that those which were subjected to the action of electric light can stand a greater heat for forcing their growth. Specnew subjected the seeds of peas, beans, barley and roses for two minutes to the alternating current of an induction coil and found that these seeds sprouted in one half the time but otherwise it does not affect the plant; experiments of others, however, have shown that continuous but weak currents through the earth surrounding the roots have a favorable action, as has also the equalization of the atmospheric electricity with that in the earth, through the plants or the neighboring earth; such a treatment of the seeds and the plants not only increases their growth but also increases the relative amount of nourishment in the fruit; with beets, for instance, the amount of sugar and alcohol was increased appreciably, as was also the starch in potatoes.

Fining Beer by Means of Electric Light.—Lond. *Elec. Rev.*, Dec. 25.—A note referring to a recent article in a German brewery paper by Reinke (who is said to be a well-known authority), showing that turbid beer can be fined to a brilliant condition by means of electric light; he found that if electric lamps are suspended in the fermenting vessels the light brings about a much quicker and better clarification, the yeasty matters being rapidly deposited together with the resinous, albuminous and glutinous substances, which are always present; the result is not due to the change in temperature.

Electrical Work in South America.—Lond. *Elec. Rev.*, Dec. 25.—A short article describing briefly the state of affairs at present in Buenos Aires.

Biographical.—Lond. *Elec.*, Jan. 1.—A biographical sketch of the late Du Bois Reymond.

Electrical Patents of 1883.—Lond. *Elec.*, Jan. 1.—A list of some of the more important English electrical patents whose natural life expires during the coming year; among them are a number of important ones, including the hot wire instruments of Cardew, the mariners' compass of Kelvin, the unipolar dynamo of Forbes; some of the dynamos of Ferranti and Hopkinson, besides a number of other patents which have already expired.

New Companies for 1896.—Lond. *Elec.*, Jan. 1.—A list of the more important companies registered during the past year, with their capital. Also a list of those which ceased to exist.

1897.—Lond. *Elec. Rev.*, Jan. 1.—A brief editorial forecast for the coming year. It is believed that there never were more hopeful prospects for the electrical industries than there are for 1897; it refers briefly to the development of electric transmission, electric traction, the supplying of foreign markets and the development of the cable and the steam engine industries.

1896.—Lond. *Elec.*, Jan. 1.—An editorial article giving a summary of the chief events of the past year.

Future Electrical Development. Dolbear. *West. Elec.*, Jan. 9.—A recent interview in which he makes a number of interesting suggestions and prophecies, a few of which may be mentioned here. Artificial Hertzian waves afford a new method for telegraphic work, which is superior to search-light signaling, and is at present limited in distance only by the curvature of the earth, although by tacking it can be carried theoretically to an indefinite distance. He thinks the method of signaling, in which a powerful beam of light is thrown on the sky or clouds, will probably soon come into common use, as, for instance, in announcing coming changes in the weather. After pointing out the inefficiency of the present systems of lighting he suggests that sheets of metal or gilt paper may be arranged on opposite sides of a room and connected to a suitable induction coil, the portable lamp being then lighted by putting it into a certain positin relative to the walls, without any connection to the source. Besides using electricity for heating it can be used for refrigerating, as water has been frozen at the junction of a thermopile, which is cooled by the passage of a current. He thinks long trains will soon be run at 60 miles an hour; in referring to the electric furnace he states that worthless fragments of rubies and emeralds are easily fused together into a large and precious gem. Electrical applications will quite supplant the common medical agencies for many diseases; life might even be maintained without food of any kind, if it is possible for it to absorb energy as matter absorbs sunshine. He thinks there is nothing in the nature of things to hinder electrical signaling between planets.

Electrical Export Trade. Knudson. *Elec. Eng.*, Jan. 6.—An article on the beginning of the electrical export trade from this country, comparing the past with the present condition and outlining some future possibilities; the statistics were obtained from consular reports and other sources, and refer chiefly to Central and South American countries, besides China, Japan and South Africa.

Electricity in Naval Life. Fiske. *Elec. Eng.*, Dec. 30.—In a continuation of the serial he describes the depression position finder, the principle of which is the same as that of the other instruments.

Submarine Photography by Electric Light. Gleaves. *West. Elec.*, Dec. 26.—A brief extract from the *Photographic Times*, in which he refers to the advantages in the case of war, sunken wrecks and for studying the bottom of the sea, which arise from the use of a photographic apparatus in connection with an electric light; an apparatus is briefly described with which objects 10 feet distant could be seen as plainly as by daylight and were easily photographed.

Resistance of the Human Body. SPEHL and SANO. *Elec. Jour.*, Dec. 15.—A translation in abstract of an article from a French journal describing measurements made to determine the conditions likely to cause variations in the electrical resistance; the results are not very definite; there seems to be a slight increase in unhealthy subjects; certain subjects had a fixed resistance while with others it varied; the same sickness gives different results with different subjects and also with the same subject; the circulation has no decisive influence.

Electrical Engineering Education. CROCKER. *Elec. Eng.*, Jan. 6.—A description of the development of electrical engineering education during the past 15 years; he believes that the changes have been even greater than in the art itself.

The Electrical Guests at the Niagara Power Celebration.

The Buffalo *Commercial*, of Wednesday afternoon, devotes more than two columns of space to pen pictures of a number of the electricians who attended the banquet given by the Cataract Power & Conduit Company. Many of the items are so interesting that we reproduce them here:

W. H. LAWRENCE, of Cleveland, is one of the men who have amassed a large fortune out of the manufacture of carbons.

BENJAMIN F. MILES, of Cleveland, is a member of the National Carbon Company. He is an intimate friend of Major McKinley.

LEMUEL BANNISTER is one of the big men from the business point of view. He is with the Westinghouse company as vice-president. He is as jolly as he is witty.

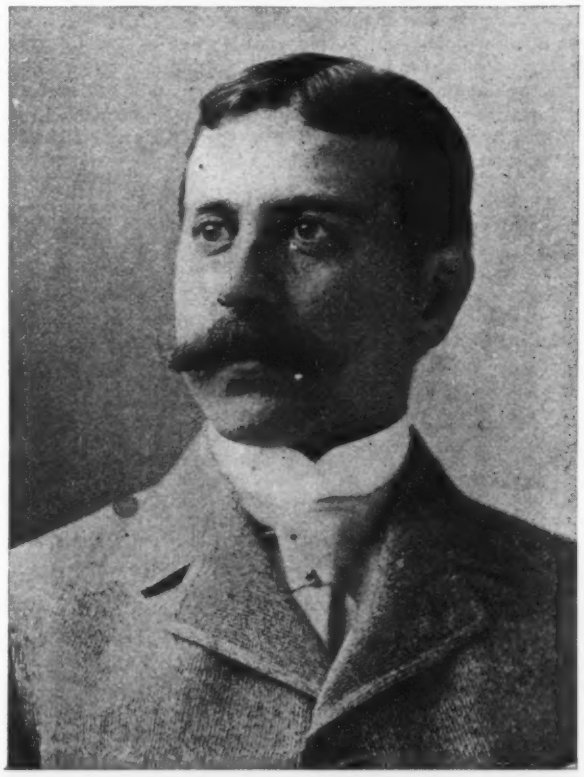
CHARLES W. PRICE, editor of the *Electrical Review*, is tall, wears a high hat and eyeglasses, and is one of the best-looking men who attended the banquet. He is a hustler.

F. A. GILBERT, of Boston, is the most prominent practical electrical expert in New England. He is heavy, wears glasses, is fond of a good story, and is a thorough business man.

SAMUEL INSULL, of Chicago, was close to Edison and worked beside the great inventor in many of his most notable achievements. Mr. Insull is president of the Chicago Illuminating Company.

W. A. BRACKENRIDGE, of Niagara Falls, is a very tall man. He is resident engineer of the Cataract Construction Company. Col. Brackenridge is a noted civil and mechanical engineer. He won fame by his part in building the elevated railway in New York.

T. C. MARTIN, of New York, editor of the *Electrical Engineer*, is a prominent writer on electrical matters, and has had many honors conferred upon him. He represented the American Institute of Electrical Engineers at the Lord Kelvin jubilee in Glasgow, Scotland, last year.



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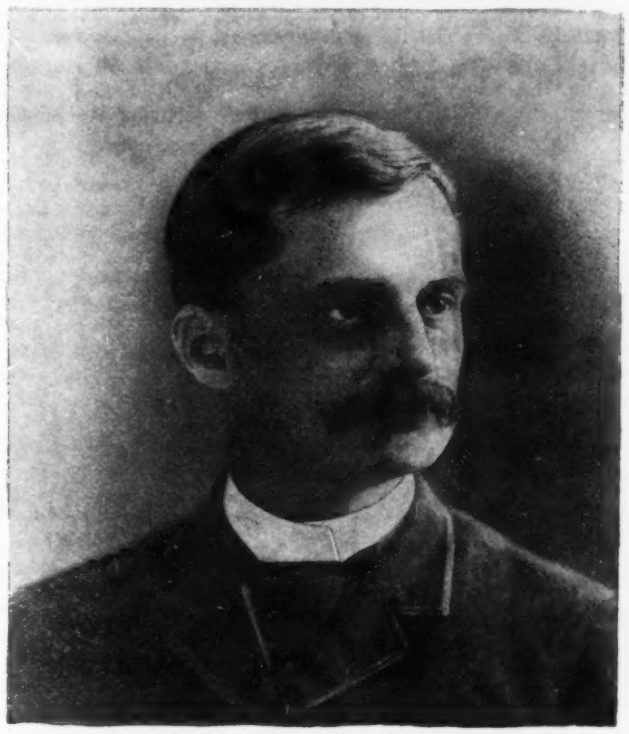
S. DANA GREENE.

E. W. RICE, JR., is a good-natured, quiet, but fun-loving man. He occupies a most important place with the General Electric Company at Schenectady. All of the electrical work passes his inspection. He is up-to-date in everything, knows everything, and, in this way, is the whole thing.

W. L. R. EMMET, of Schenectady, is one of the most affable men at the banquet. He was formerly an engineer in the navy. He has charge of all the alternating work of the General Electric Company and is considered one of the best posted and most progressive of the younger electrical engineers.

C. P. STEINMETZ is a medium-sized, wiry, pleasant man. He revels in the calculus and is regarded by his friends and admirers in the electrical world as a mathematical prodigy. To him figures are playthings. He is equally at ease whether puffing a cigar or busily figuring out a mathematical problem.



ELIHU THOMSON.

J. P. ORD is a man everybody in the electrical world likes and is glad to know. He is the first vice-president of the General Electric Company. He is a business man who ranks high in the business world. He is fond of a good dinner and of a good story and is often in the centre of a circle of laughing friends.

FRED NICHOLS, jolly and full of life, is president of the National Electric Light Association, the first man outside the United States elected to that office. He is general manager of the Canadian General Electric Company, and president of the Toronto Illuminating Company. Mr. Nichols ranks high as an expert in electricity.

WEBB C. HAYES is a medium-sized man, young and quiet, yet active and entertaining. His face causes people to look twice at him. It resembles in general features that of his honored father, Rutherford B. Hayes. Webb C. Hayes is one of the brightest men connected with the National Carbon Company and is its treasurer.

W. J. JOHNSTON, publisher of THE ELECTRICAL WORLD, is an interesting man. He is the oldest writer on general electrical subjects in the country, being the publisher of the first periodical devoted to general electricity. He was the originator and publisher of the little journal which years ago was devoted to telegraph operators and operating.

S. DANA GREENE, of Schenectady, assistant general manager of the General Electric Company, is a tall, slender, good-looking young man, full of energy, who walks and talks and smokes quickly. He is a son of the naval officer who commanded the *Monitor* in her battle with the *Merrimac* during the Rebellion. One of the youngest men in the electrical business, Mr. Greene is considered to have a great future in his profession.

NIKOLA TESLA naturally attracted great interest at the banquet. Tall, dark-complexioned, quick and nervous, Tesla is a bundle of nerves held in place by a marvelous brain, and the one, all-absorbing aim of his life is to master the great and mysterious force of nature, electricity. It is seldom that he consents to speak in public about his work or his discoveries. He spoke last night as one whose brain reaches far out and grasps hidden mysteries and solves the most baffling problems before others have an intimation that they exist.

L. B. STILWELL, of Pittsburg, would be picked out immediately as a man of great energy, quick perception and unusual ability. He is of medium height, and dresses well but very neatly. It was he who put the finishing touches to the great dynamos which are in use at the Falls. He is one of the practical men who do the work of the Westinghouse Electrical & Manufacturing Company. Mr. Stilwell is in merry mood these days. As he started for Buffalo his son, six months old, sent after him one of his first efforts to say "Dadda."

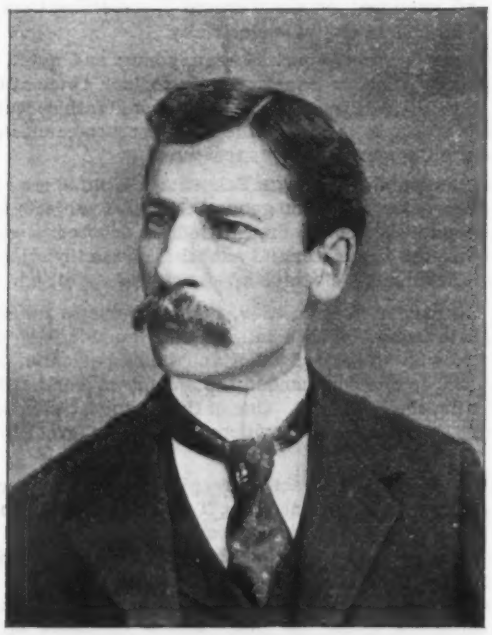
Elihu Thomson is a quiet, somewhat reserved, pleasant-faced gentleman, noted for his good qualities of heart and great power of brain. Following closely in the footsteps of Mr. Brush has been Elihu Thomson in the production of the arc light for street lighting, and the invention of incandescent dynamos. He is also distinguished by his original invention of alternating apparatus. Mr. Thomson is one of those men who say little, but saw a great deal of electrical timber, which is used to much advantage in commercial and public avenues.

Charles A. Coffin, of Boston, is president of the General Electric Company. He hails from Boston and has the dignity and good bearing which accompanies the suave and business-like New Englander.

Charles A. Coffin.

Formerly Mr. Coffin was a manufacturer of shoes. President Coffin is declared to be among the foremost of the best and shrewdest business men in the United States. He is successful in everything he undertakes. He is one of the business men who "make no fuss about it," but who get there by patient and intelligent effort.

James P. Humbird, of Pittsburg, is widely known because he was instrumental largely in placing the first alternating dynamos which furnished electric light to stores and private buildings. He is a man in whom Buffalonians would take greater interest if they were more familiar with his achievements. It was Mr. Humbird who, in 1886, installed the alternating dynamos at the works of the old Brush Electric Light Company and in the store of Adam, Meldrum & Anderson. This is said to be the first establishment of the alternating system of electric lighting.



Frank J. Sprague.

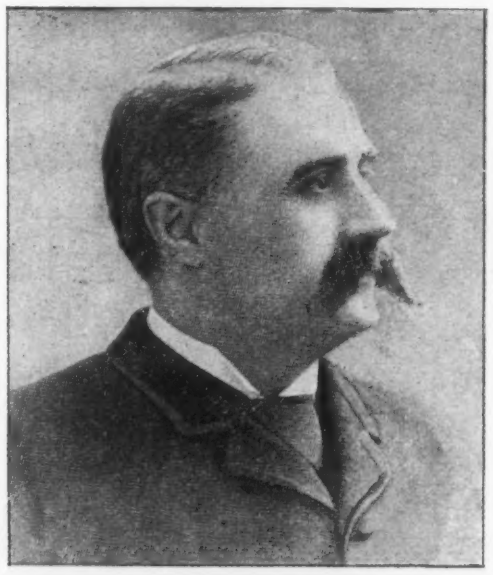
Frank J. Sprague, one of the most celebrated men at the banquet, received his early training as an engineer in the navy. He it was who first utilized electricity as motive power for surface roads. He built the first electric railway and demonstrated the success and feasibility of his invention in Richmond, Va. He is also a joint inventor of the electric elevator. He designed and built the electric elevators in the Guaranty Building, the only ones of the kind in Buffalo. Mr. Sprague is yet young and is one of the most progressive men among the electrical inventors.

Huntley and Urban are both tall and great hustlers. No other two men could possibly have induced such a number of big electrical men to attend a banquet, no matter if it was ten times as grand. But all came who could because they knew Charley and

Charles R. Huntley.

George; they knew that Buffalo would be theirs while they remained; they knew that the work of these two men and other Buffalo men in connection with the power-bringing deserved recognition. They are a great pair, and Buffalo is fortunate in having two such men. The banquet was a very great success, and Huntley and Urban deserve credit for it.

Charles F. Brush is a big man in every way. He is 6 feet 2 inches tall, always ready for a pleasant bit of repartee or a good story—and for business. Mr. Brush was the first to make practical the use of the arc lamp. He made the first machine which supplied street light. It was a one-light machine. He has developed his theories and his inventions, until to-day he makes a machine which furnishes 125 arc lights. Mr. Brush is a broad-gauged, whole-souled, manly man of brilliant and most congenial qualities, who is beloved for his personal traits and admired for his genius by all who know him. He is probably the richest of the electrical men who sat at the tables last night.



Charles F. Brush.

E. G. Acheson, now of Buffalo, but originally a Pittsburg man, is large, jolly and always brimful of good nature and fun. He is the inventor of carborundum, and is at the head of the carborundum factory at Niagara Falls. Mr. Acheson was one of the first men who worked with Edison at Menlo Park and was sent to Europe by the famous inventor to introduce and install Edison's system of incandescent lighting. Mr. Acheson is

always ready to receive and to instruct and to entertain guests at his factory at the Falls. Some time ago he showed a party of Buffalo school teachers through the works, and when they departed each had a beautiful souvenir of the visit made while the teachers waited, and declared that Mr. Acheson was "the dearest gentleman" they had ever seen—so says a friend of the inventor of carborundum.

Natural Draft Transformers.

One of the forms which the transformer for use with high-voltage currents has taken is shown in the accompanying illustrations of the special "type H" natural-draft type, developed by the General Electric Company in its long-distance transmission work. In transformers of this type the primary coils, well taped and bound, are insulated from each

FIG. 1.—TRANSFORMER COILS.

other by thick layers of felt; in that shown the primary coils are eight in number. Between the coils of the primary and the secondary winding an air space of one half an inch intervenes. The whole is mounted upon a

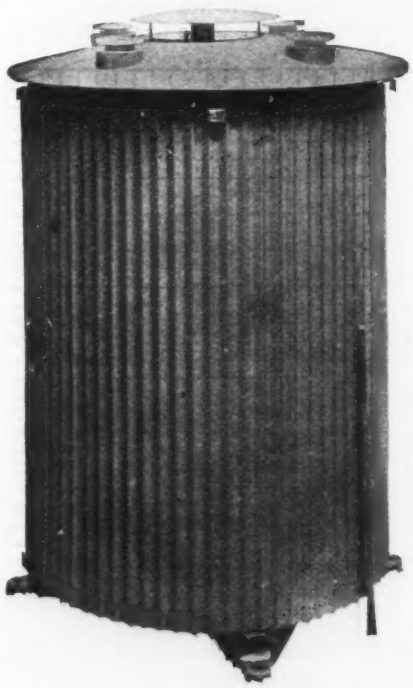


FIG. 2.—TRANSFORMER ENCLOSED.

solid iron foundation and securely braced, and is then covered with a corrugated iron cylinder provided with a ventilating roof.

One of the first transformers of this type has been for the past five months in service where it is necessary to reduce directly from 10,000 volts to 125 volts without intermediate transformers. It is used on the transmission lines of the Redlands Light & Power Company at Redlands, Cal., to furnish low-voltage current at a point some 10 miles away from the sub-station secondary lines.

The Puritan Arc Lamp.

The Puritan alternating-current arc lamp, which is one of the latest new comers in the market, is, we are informed, rapidly growing in favor.

The Puritan Electric Company, 150 Nassau Street, New York, the manufacturer of this lamp, is now ready to fill orders for lamps to burn on series arc circuits. The lamp takes 6.8 amperes at 70 volts, and is noiseless in operation, which is one of its main distinguishing features.

As was stated in THE ELECTRICAL WORLD of January 2, the Puritan lamp is of the 100-hour type, the carbons being enclosed in a manner precisely like those in the enclosed arc lamps used on the continuous-current constant-potential circuits.

THE PURITAN ARC LAMP.

In each of two large western and southern cities 30 to 40 Puritan alternating arc lamps are now in use and giving the best of satisfaction. Some of these lamps were furnished on duplicate orders and in one instance a lot had to be shipped by express at great extra cost in order to hurry them through.

The Company has opened an office in the John Hancock Building, in Boston, which will enable it to better handle and supply the New England trade.

The accompanying cut illustrates the lamp in position for trimming. The globe in easily lowered and held secure in this position until the trimmer has finished his work, when it is slid back into place as readily as it was lowered. This is an excellent feature and will be appreciated by those who have the practical handling of the lamp.

The Electrical Mercantile Agency.

This agency, whose headquarters are at 318 Broadway, New York City, is of a special character, its business dealing with the general electrical trades. The association claims to have special facilities not enjoyed by general agencies of this character for obtaining advance information, correct, up-to-date, comprehensive and reliable. It also claims the same superiority in the electrical line that is accorded to specialists in any branch of professional or mercantile industry. It devotes all of its time and attention to this one line of trade and is in daily receipt of hundreds of communications from all parts of the country, containing information concerning changes materially affecting the business worth and credit standing of the 12,000 to 15,000 concerns recorded on its books. It claims to save some one of its subscribers almost daily several times the cost of his subscription by means of the special information imparted. It is in intimate touch with all branches of the electrical trade and its system is said to be a practical guarantee against loss from bad accounts except in the event of sudden failures of very large houses, and even in such cases the association is frequently able to give information sufficiently early to enable its clients to protect themselves.

The points of superiority in its own system over general agency systems, to which it directs attention, may be briefly mentioned as follows: Its reports are written up from personal statements, trade information, special information and reports furnished to it by its various correspondents and reporters, each being carefully checked and compiled by men who have been identified with the electrical business for the past 15 years. These are assisted by men who have a thorough familiarity with the mercantile agency through long service. The company claims to have special sources of information from five large companies who probably, collectively, do business with everybody engaged in the electrical trade in the United States and Canada. The association makes a specialty of following up month by month the various concerns inquired about and sends its subscribers the additional information thus obtained as fast a it comes in, without waiting for special requests. In this way the subscribers are constantly posted on changes affecting their customers. The

agency publishes a Credit Reference Book semi-annually, in April and October, in which the changes which took place on Jan. 1 and July 1 are given, and its weekly correction sheet renders it possible to keep the book constantly up to date. In addition to this service the company is well equipped to effect prompt collections, and in a great majority of cases can secure payment without subjecting its clients to expensive legal proceedings. It is operating this branch of its business not for profit but to increase the value of its general service which it believes in a short time will be considered indispensable to every business house of any importance in the electrical trade.

Lightning-Arrester for High-Tension Alternating Circuits.

The lightning-arrester shown in the accompanying illustrations is designed for single-phase and other alternating currents with tensions from 2000 volts upward. It consists of two stout copper wires bent to suitable curves and borne by porcelain insulators. The form found best for the wires is that shown in Fig. 1. The distance between the two wires can be regulated according to the tension in the circuit. The lower ends of the wires are threaded and held in a horizontal hole in the upper cap by two nuts. Each of the lower caps bears a clamp nut. One of these nuts is a screw-connection with the circuit to be protected, on the other a screw-connection with the earth connection. Should, in consequence of a lightning stroke, an arc form between the two bent copper wires, the action of the ascending current of warm air, and the electrodynamic working of the currents in the wires carries it upwards. As the wires separate more and more as they ascend, the arc must thus become weaker and then be broken.

This arrester is claimed to have the advantage of the greatest possible simplicity, having no moving parts, no electromagnets or other mechanical contrivances to break the arc. It is nearly entirely free from self-induction, a quality which is indispensable in a good lightning-arrester. The wires are so little affected by the arc that they should last for years, and at most require to be rubbed bright with emery-paper from time to time.

It is recommended by the makers (Siemens & Halske), that the device be housed, to protect it from rain. There must be a free space above it of at least a metre (say 40 inches) as the arc (especially in large plants) can attain considerable magnitude. There must be no combustible materials in the neighborhood. If the device is crowded for room, the walls and ceiling must be covered with asbestos board.

The distance required between the wires at their nearest points is one millimetre (0.039 inch) for each 1000 volts tension.

The device may be installed in the open air without roof, but in this case one may expect, when it rains heavily, the formation of arcs between the wires, although usually they are soon broken. Where the device is installed in the open air the minimum distance between the wires must be increased to at least 10 millimetres—say 0.4 inch. As this lightning arrester is free from self-induction, its operation would not be greatly hampered from installation in the open air if the lightning had to overcome self-induction in the circuit itself.

Now long free circuits have always quite considerable self-induction.

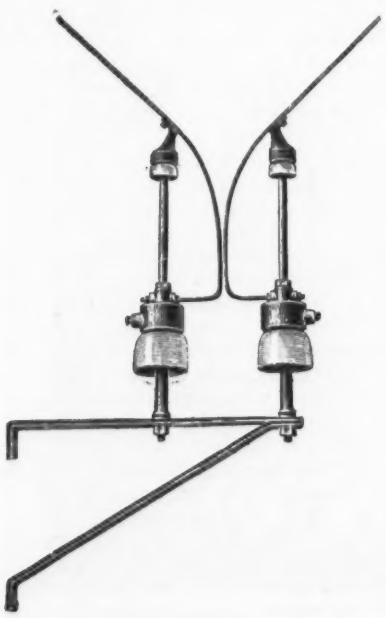


Fig. 1.—Lightning Arrester.

In such cases the arrester can of course be installed in the open air. Care must be taken that the arc flame does not strike the circuit; the arrester hence must be put at the side or above the line. If it comes near generators, motors or transformers, then some more self-induction must be introduced between these and the arrester.

This is most simply done by forming the line in the neighborhood of the machine into a spiral having a coil diameter of about 100 mm, say 4 inches, and a distance between coils of about 10 mm, say 0.4 inch.

Fig. 2 shows the arrangement for a direct-current circuit having self-induction coils and earth plate connections. One must be careful to avoid in the connections which lead from the line to the arresters and from these last to the earth all kinks and short bends in order to avoid self-induction as far as possible. The connections with the earth should contain no safety fuses as these might cut the lightning off from the earth at the wrong time.

For earth plates or connections the best thing is a galvanized iron plate of about 1.5 square metre (say 16 square feet) surface on each side;

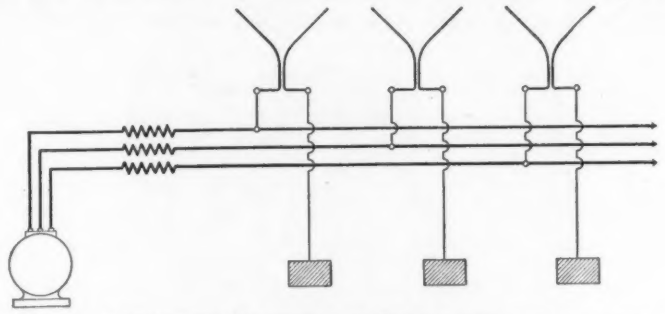


Fig. 2.—Lightning Arresters on Direct-Current Circuits.

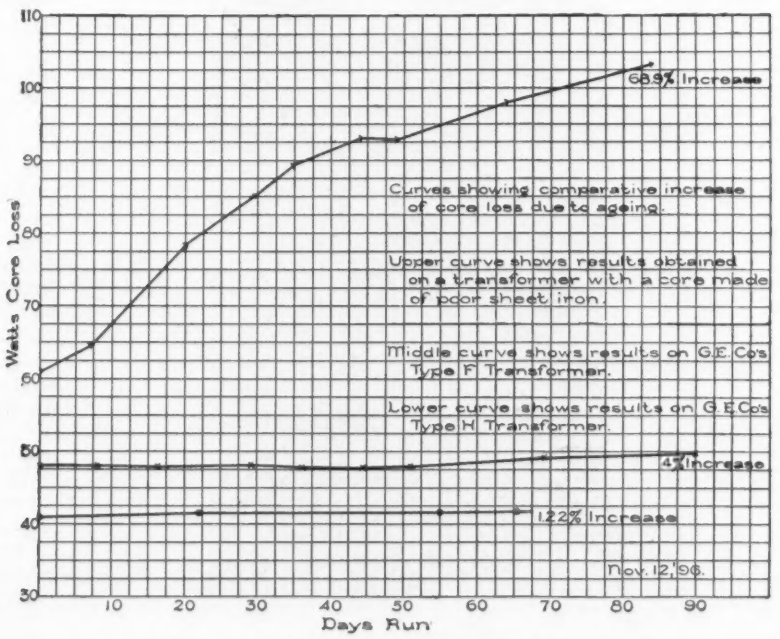
and it should when possible be laid in wet ground. If the latter is not accessible the earth plates should have good connections with the earth by embedding in the finely-ground and well damped coke, or at least a mixture of this and earth, a volume of at least 2 cubic metres (say 70.6 cubic feet) being necessary.

Separate earth plates are preferable to a single one, as they afford less opportunity for short-circuiting. Where rods and pipes are used as earth connections, they should lie for at least five metres, say 16½ feet, in water. As connection between the arrester and the earth-plates, tinned copper wire is recommended, of a cross-section of at least 25 square millimetres—say 0.04 square inch. The earth connection should always be laid where it is in sight.

Magnetic Fatigue or Ageing of Transformer Cores.

It is now a well-recognized fact that the loss in a given body of sheet iron subjected to a definite number of magnetic reversals per second and at a definite density of magnetization does not of necessity always remain the same. It is only by the greatest care that iron is brought into the condition in which it gives a minimum loss when subjected to alternating magnetization, and the manner in which this result is obtained and the conditions to which it is subjected in actual use have both to be considered to ensure keeping it in this condition.

Failure to properly consider these facts will produce a transformer



Curve of Results from 2500-Watt Transformer.

which may give a fairly low core loss when first produced, but which, after being in use for a short time, will give a core loss 25 per cent., 50 per cent. or even 100 per cent. greater than at the start.

This phenomenon is popularly known as "ageing." A curve of actual results recently obtained on a 2500-watt transformer of well-known make

is here given as a practical illustration of this fact. At the time of the last test the increase in core loss, it will be seen, was 68.9 per cent. after a run of 90 days under normal conditions of commercial operation.

To reduce this loss in its transformers has formed the subject of exhaustive study by the engineers of the General Electric Company, at Schenectady. The result of continued experiment allows this company to guarantee its transformers as free from the serious defect of "ageing"; in most cases absolutely negligible and in extreme cases not more than 4 or 5 per cent. On the same curve are given the actual results obtained on one of the General Electric standard type H 60-cycle transformers, and from this it will be seen that the loss comes within the above limit.

Special Slow Speed Motors.

The Northern Electric Manufacturing Company, Madison, Wis., has been making a special feature of small slow-speed motors built particularly for direct connection to all kinds of machines, particularly printers' machines and leather makers' machines. Its motors are well adapted to this line of work, being very compactly built in steel spheres, and so constructed that they may be hung inverted from the ceiling and attached without any extra fixtures to line shafts, or direct to the various machines. All of the bearings of the machines are self-aligning and self-oiling, and the manufacturers claim that they require practically no attention other than oiling them about once or twice a month.

This company is operating in commodious new shops erected at Madison, Wis., modern in every detail and electrically driven. It has strong financial backing and a full share of patronage seems to be assured for it.

The company has recently closed a contract with the Germania Publishing Company, Milwaukee, Wis., for the entire equipment of all the machines and presses in the latter company's building with "Northern" steel clad direct-connected slow-speed motors. This building has been laid out with the utmost care regardless of expense and the president and principal owner, Mr. George Brumder, is determined that it shall be the finest equipped printing establishment in the West. This contract we understand was secured only after severe tests of these machines.

Direct-Connected Gas Engine and Dynamo.

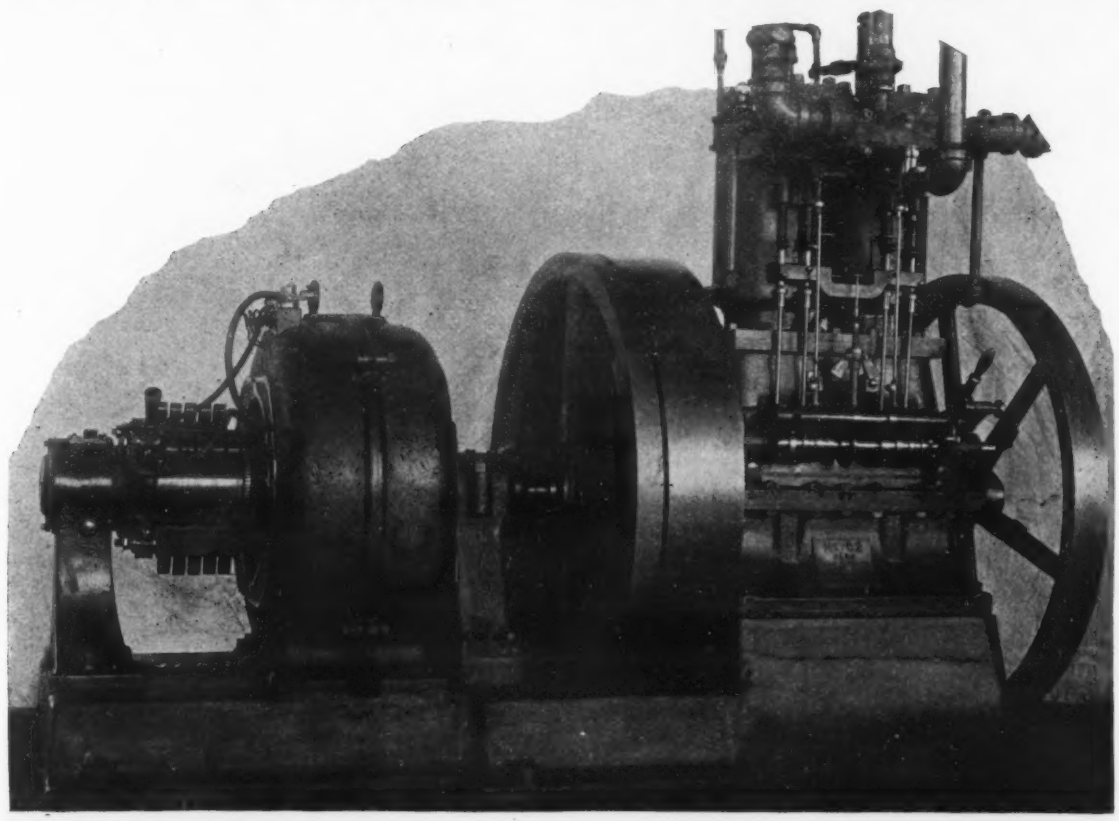
The satisfactory operation of a direct-connected gas engine and dynamo, the latter directly supplying current to arc and incandescent lamps and motors will no doubt be questioned by many. Belt or similar driving gear seems to have been considered essential in past practice and even then the speed fluctuations in some engines are frequently objectionably manifested by consequent pulsating voltage and flickering light. As the power is derived from a series of explosions occurring at regular intervals, all gas engines are subject, more or less, to this pulsation, although heavy fly-wheels, a multiplicity of cylinders with alternating explosions and efficient governing mechanism tends to make this feature less apparent.

The National Meter Company, 298 Broadway, New York City, manufacturer of the Nash gas engine, has recently developed a direct-connected gas engine and dynamo combination, which, in view of the above, is particularly interesting. All Nash gas engines are of the vertical type.

The engine for electric lighting purposes is constructed with two "Otto cycle" cylinders, working alternately so that an explosion occurs every revolution of the fly wheel. An incandescent tube or electric spark ignition is used to explode the mixture of gas and air in the cylinders which are water jacketed. As will be seen from the illustration the crank shaft and connecting rods are entirely enclosed in an oil filled case. The valves are of the poppet type. Regulation is accomplished by means of a variable gas admission controlled by a wheel governor which varies the valve opening. In the direct-connected arrangement the engine is bolted at one end of a heavy foundation casting. The dynamo of any suitable construction is fastened at the other end of the base and connected to the engine shaft by means of a friction clutch of peculiar construction. This clutch is located inside of the fly-wheel and automatically controls the dynamo speed in spite of the pulsating movement of the engine.

One of these direct-connected sets, consisting of a 20-hp engine and Riker multipolar dynamo, has recently been installed in this city. The engine runs at about 280 revolutions per minute. Current from the dynamo is supplied to a number of arc and incandescent lamps at about 110 volts. A close inspection of the voltmeter failed to show any pulsating effect; in fact, the steadiness of the voltage appeared to be far above the average obtained in gas-engine plants. The illustration shows a similar set consisting of a 30-hp engine and 15-kw Lundell dynamo.

The National Meter Company is ready to furnish direct-connected generating sets up to 15 kilowatts, but intends to perfect larger sizes up to 150 kilowatts. The company has nearly completed a large vertical engine which is rated at 200 actual horse-power at about 200 r. p. m. This engine is in general similar to the smaller sizes excepting that four cylinders are used instead of two, the pistons acting in pairs, and an explosion in one cylinder occurring at each stroke, up or down. The dynamo to be connected to this engine is a 150-kw 500-volt Walker multipolar railway generator, having its armature rigidly connected to the engine shaft. The engine is equipped with a very heavy fly wheel, which in connection with the four-cylinder arrangement is expected to give a sufficiently steady action for power purposes.

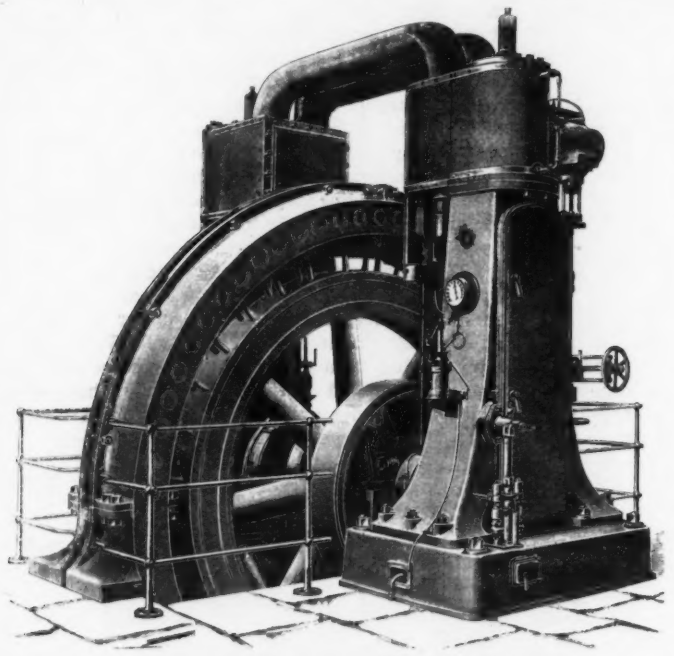


GAS ENGINE AND DYNAMO COMBINATION.

It is claimed that this is the largest direct-connected gas engine ever built and the largest gas engine used for electrical generation in this country. It is intended to operate this engine with producer gas in competition with steam units of similar capacity. Results approximating one pound of coal per hp-hour are hoped for.

Electric Lighting Plant in Bolton, England.

The electric lighting in Bolton is a municipal undertaking, and worked as a branch of the Corporation Gas Department. The station was opened in November, 1894, according to London *Engineering*, the original generating plant consisting of two vertical, compound non-condensing engines of 160 brake horse-power and one 80 brake horse-power, by Messrs. J. & E. Wood, of Bolton, driving by rope gearing two 100-kw and one 50-kw alternators of the Mordey-Victoria pattern, supplied by the Brush Electrical Engineering Company. As early as the beginning of 1895 it was seen that the above plant would shortly be inadequate to meet the demand, and the contract for the first set of engines and dynamos, which we illustrate above, was placed with Messrs. Hick, Hickgreaves & Co., Ltd., of Bolton, and Messrs. S. Z. de Ferranti, Ltd., of Hollinwood. The satisfactory working of this plant led to a similar engine and dynamo being ordered for the season of 1896, and this is now working. A third set has been ordered for 1897, and a fourth set for 1898. Each unit, as will be seen from the illustration, consists of a vertical compound two-crank engine driving a fly-wheel alternator fitted directly on the crank-shaft between the high pressure and low pressure standards. The engine is designed to give at full load 270 brake horse-power and 300 indicated horse-power, working without condensation at a speed of 157 revolutions per minute, with 120 pounds steam pressure.



One of the Generating Units at Bolton.

The cylinders are 16 inches and 27 inches in diameter by 18-inch stroke, the high-pressure having a piston valve controlled by a shaft governor, and the low pressure a plain slide-valve. A special feature of the engine is the closed standard, access to the working parts being provided for by a door forming practically the whole front of the frame, closing oil and water tight on a faced joint. The crank-shaft is carried in two bearings only, the steps of which are lined with white metal and fit into spherical recesses in the base plates, allowing perfect freedom for self-adjustment. The cranks are overhung and provided with balance weights. Forced lubrication is provided by an oil pump driven off each cross-head through a rocking shaft, which also serves to work the indicator, the parts thus supplied being the crank-neck, crank-pin, cross-head pin and slides. The piston and slide-valve rods are fitted with the builders' patent Soho floating metallic packing, and the engines are provided with a very complete equipment as regards cylinder lagging, indicator cocks, lubricators, oil splashers, etc.

The alternators were supplied by Messrs. Ferranti under a separate contract, and are designed for an output of 200 kilowatts. The engine fly-wheel supports the rotating armature of the machine, the wheel being 10 feet 3 inches in diameter, and weighing 8½ tons. This wheel is secured in position the way usually adopted by Messrs. Ferranti—of boring the wheel to a dead size, and securing it in position by means of two tire-rolled steel hoops shrunk on the boss of the fly-wheel. The wheel is made with eight arms, and is cast in halves, with splitting plates between the bases of the arms. The armature is supported by 64 radial spokes or bolts, fixed by an equal number of steel nuts inserted in cored holes in the periphery of the wheel, the nuts being insulated and carried from the wheel by means of a cement compound. After the nuts were placed in position, they, together with the bolts, were tested with a pressure of 6000 volts, or three times the working pressure of the machine. The armature, consisting of 64 coils, is constructed as follows:

Each armature bobbin is wound on a laminated brass core, each lamination being keyed to the next by means of corrugations. On this core is wound bare copper tape, the tapes being separated by insulating material, also corrugated, the result being a very stiff bobbin, although made of comparatively flimsy material.

Each pair of these bobbins is mounted in a pair of heavy gun-metal clamps, from which it is insulated with mica. The clamps are secured in position by riveting the whole together, while the bobbins and clamps are held up in an hydraulic press. Each set of bobbins is then mounted on the radial spokes above mentioned, and is pulled home by means of nuts on each radial bolt, the armature being keyed together by the corrugations before mentioned. The armature is easily adjusted by pulling down the bolts on one side or the other.

The armature runs between 64 electromagnets on either side, magnets being supported in cast-iron frames which are carried from two independent base-plates grouted into the cement foundations. Each pole-piece is surrounded by a coil of copper tape wound on edge, each coil being insulated from the pole-piece by waterproof insulation and the turns of the coils being separated from one another by the same material. This construction results in the deterioration being reduced to a minimum, while giving a very fine appearance. Suitable hand racking gear is provided, so that the field-magnet frames can be opened or closed, thus enabling the armature and field magnets to be easily cleaned.

The machine when working at 157 revolutions per minute and at full load, requires an excitation of 1¾ per cent., an air gap being one quarter inch on each side of the armature. The mechanical efficiency of the plant, owing to the absence of any bearings on the alternator, is very high. The actual tests at full load, and including the power taken to excite the alternator, show a combined efficiency of 88 per cent. $\left(\frac{\text{E. H. P.}}{\text{I. H. P.}}\right)$. The highest temperature at any point of the machine after six hours' full load was 30 degrees Fahr. above engine room.

The combination or unit described is very compact and occupies but little floor space, while the simplicity and fewness of parts enable it to be easily worked and maintained. The running is very steady and quiet, and the parallel working of the alternators at 83 alternations per second leaves nothing to be desired.

On Friday, Nov. 29, 1895, a trial of one of these sets of engine and machine was made at the Bolton Electricity Works and the results obtained are given in the annexed table and indicator diagrams, the latter referring respectively to the first and last of the tests. It will be seen that the combined efficiency of the plant was very high, ranging from 84.4 per cent. at about half load to 90 per cent. at full load.

Results of Trials.

Time.	Revolutions per minute.	Boiler pressure.	Current.		Horse-power.		Total Indicated Horse-power.	Total Electrical Horse-power.	Efficiency of Plant.
			Amperes.	Volts.	In High Pressure Cylinder.	In Low Pressure Cylinder.			
A. M.		LBS.							P. C
9.20	152	118	54	2000	84.7	87.1	171.8	145	84.4
9.25	154	116	55	2020	82 8	88.0	170.8	148	86.6
9.30	154	117	74	1960	105.2	121	226.2	194	85.6
9 33	152	117	90	1910	120.5	138	258 5	230	89.0
9.35	154	117	90	1990	123 5	153	276.5	240	86.7
9.40	154	115	91	1990	122.5	152	274.5	242	88.1
9.43	154	115	99	1960	129.2	163	292 2	260	88.9
9.45	152	116	100	1960	130 2	165	295.2	263	89.1
9 50	152	116	190	1980	132 2	164.5	296 7	266	89 6
9.55	152	116	100	1940	129.2	163	292.2	263	90 0

The first of these units was built to the specification of Mr. J. H. Ryder, Assoc. M. Inst. C. E., M. I. C. E., then borough electrical engineer for Bolton, and now occupying a similar position at Plymouth, and its successful working led to his recommendation of a similar unit for the first extension, and to a like recommendation on the part of Mr. Arthur Ellis, A. I. E. E., the present borough engineer, as regards the second and third extensions.

The First Saw Mill Operated by Electric Power.

The saw mill of the American River Land & Lumber Co., which is located close to the power house at Folsom, Cal., of the Folsom-Sacramento power transmission, was started successfully on the 1st of December last, cutting 50,000 feet of lumber per day. The saw mill is the first in the country and indeed in the world, which is operated by electricity.

The current is three-phase, taken from the power house at Folsom, and the motors are all of the induction type, the installation having been made by the General Electric Company. The motors employed are one of 75 horse-power, one of 50 horse-power, both running at 720 volts, three of 30 horse-power and one of five horse-power, operated at 200 volts.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Jan. 13, 1897.

ELECTRICAL STOCKS.—There was a little more firmness to the market during the past week, as is manifested by the general improvement in quotations. The advances, although fractional, indicate a stronger tone.

TELEGRAPHS AND TELEPHONES.—What few changes are recorded are, as a rule, improvements over last week's figures. The changes are not marked, however, but the tone of the market seems to be more vigorous, and prices are not tending downward.

ELECTRIC TRACTIONS, with two exceptions, are all lower in price than they were at the time of our last quotations. The market was weaker last week, the declines being general and fractional. There does not seem to have been any special influence at work to depress the market; slack demand is probably responsible for the depression.

THE EDISON ELECTRIC ILLUMINATING COMPANY, of Brooklyn, has made application for permission to increase its capital stock $600,000 for the purpose of extending its business.

DIVIDEND.—The Columbus Street Railway Company, Columbus, O., has declared a dividend of 1 per cent., payable Feb. 1. The report of the company for December shows gross earnings of $52,523, a decrease of $2285 as compared with the same month in 1895, and net earnings $26,544, a decrease of $1594. The gross earnings for the year ending Dec. 31 were $631,623, an increase of $1328 as compared with the previous year, and net earnings $322,879, an increase of $4478.

ELECTRICAL STOCKS.	Par.	Bid.	Asked
Chicago Edison Company	100		
Edison Electric Ill., New York	100	103½	104
" " " Brooklyn	100	88	93
" " " Boston	100	..	..
" " " Philadelphia	100	..	.
Edison Ore Milling	100	7½	10
Electric Storage Co., Philadelphia	100	28⅞	29
Electric Storage, pref	100	30½	31
General Electric	100	33⅜	33¾
General Electric, pref	100	75	77
Westinghouse Consolidated, com	50	..	24
" " pref	50	50½	52
BONDS.			
Edison Electric Ill., New York	105	105	..
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	90½	—
TELEGRAPH AND TELEPHONE.			
American Bell Telephone	100	209	210
American District Telegraph	100	*29	39
American Telegraph & Cable	100	85	90
Central & South American Telegraph	100	124	127
Commercial Cables	100	160	172
Erie Telephone	100	64¼	65¼
New England Telephone	100	102	..
Postal Telegraph-Cable	100	91	94
Western Union Telegraph	100	83½	83¾
ELECTRIC TRACTION STOCKS.			
Baltimore Traction	25	17¼	17⅜
Brooklyn Rapid Transit		18¾	19
Brooklyn Traction	100	..	14
" " pref	100	46	48
Buffalo St. Ry	100	73	77
Cleveland Electric Ry	100		..
Columbus St. Ry	100	39	42
Hestonville	100	51	51½
" pref		..	62½
New Orleans Traction	100	9	11
" " pref	100	40	50
North Shore Traction	100	21	24
" " pref	100	72	78
Rochester St. Ry	..	.	20
Steinway Ry	..	45	50
Union Railway (Huckleberry)		98	103
Union Traction, rcts $10 pd	..	12¾	13
West End, Boston	100	64	64¾
" " pref	100	87	..
Worcester Traction	100	19½	21
" " pref	100	94½	97½
BONDS.			
Brooklyn Rapid Transit 5s. 1945	100	77¾	..
Buffalo St. Ry. 1st con. 5s	100	*106	109
Cleveland Elec. Ry. 1st mtge 5s	100	102	104
*Columbus St. Ry. 1st 5s	100	94	96
Rochester St. Ry. 1st 5s	100	..	100
Union Railway (Huckleberry) 1st mtge 5s		*101	104
*Westchester Electric 1st mtge 5s	100	100	103

* With accrued interest.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Jan. 14, 1897.

MESSRS SIEMENS & HALSKE, Berlin, Germany, inform us that they have constructed the electrical underground road in Budapest, described in THE ELECTRICAL WORLD of Oct. 24, 1896. In the description there given Mr. Herzog failed to give credit to this firm for the important part of the work which it carried out.

ELECTRIC LIGHTING AWARD.—The Gas Commission has awarded a contract for lighting Mount Morris Park, Madison and Union Squares and upper Broadway. The contracts let were to the Mount Morris Electric Light Company, 92 lamps at 45 cents each; the Manhattan Electric Light Company, 10 lamps at 50 cents each.

FIRE.—The factory of the Gordon-Burnham Battery Company at 82 West Broadway, was damaged by fire on the night of Jan. 6. The damage was confined to the stock and was settled by the insurance company for $450. The Gordon-Burnham Battery Company was little delayed by the mishap and is now able to promptly fill its orders.

THE RAPID TRANSIT COMMISSION.—The Board of Rapid Transit Commissioners held an executive session on Jan. 11, at which the following resolution was passed unanimously: RESOLVED, that it is the sense of the assembly that no plan should be adopted contemplating the building of a railway under Broadway, south of Park Row unless the owners of a majority of the property consent thereto.

NEW ELECTRICAL JOURNAL.—*Wire* is the name of a new 16-page paper which has just made its appearance. It is to be published monthly in New York, at 229 West Twenty-eighth Street, Mr. Leonard F. Requa, Jr., being its editor, and Mr. H. T. Richards business manager. Judging from its title the paper is evidently intended to advance education on the subject of wires, and the first number contains some very readable articles.

ELECTRICAL SOUND MONEY CLUB.—At a special meeting of the officers and committee of the Electrical Sound Money Club, held at the offices of the treasurer, Capt. W. L. Candee, 253 Broadway, New York City, on Jan. 8, it was voted that in view of the fact that the objects for which the club was formed had been successfully accomplished, the club be dissolved. It was also voted that the treasurer be appointed a committee of one to dispose of to some charitable object the small balance of cash on hand. Resolutions of thanks were passed for favors extended by various corporations, and a special vote of thanks was tendered to General Barney for the excellent work he did in organizing and commanding the 1832 men turned out in the business men's parade by the Electrical Sound Money Club.

THE RÖNTGEN-RAY APPARATUS AT THE ORTHOPÆDIC DISPENSARY.—In THE ELECTRICAL WORLD of Jan. 2 was published an illustrated description of the Röntgen-ray apparatus, installed in the Orthopædic Dispensary and Hospital, New York City. In justice to Mr. E. B. Meyrowitz, 104 East Twenty-third Street, it should be stated in this connection that that gentleman furnished the coil, tubes, rotary break and other apparatus forming the Röntgen-ray outfit, the same being operated at the opening reception by Mr. Meyrowitz's representative. Messrs. J. Jones & Son installed the electrical plant in the hospital, and the wiring and installation of the Röntgen-ray apparatus devolved upon them as part of the contract, the apparatus itself being supplied by Mr. Meyrowitz as above stated.

MR. STUART W. WISE, formerly officially connected with the Manhattan General Construction Company, New York, is now president and general manager of the Puritan Electric Company, manufacturer of the Puritan alternating-arc lamp, with offices in the Tract Society Building, New York City, and the John Hancock Building, Boston. Mr. Wise is a young man, but old in electrical experience, especially in the line of street railway construction, having built the first electric road in France, in the City of Bordeaux, using the French Thomson-Houston system. He also built a road in Havre. When the formation of the Manhattan General Construction Company took place, Mr. Wise was offered the position of secretary and treasurer of the company, which he accepted, remaining with the company until his recent appointment, as above noted.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, MASS., Jan. 12, 1897.

MR. A. ARTHUR ZEIGLER, president of the Zeigler Electric Company, Boston, is receiving congratulations. It is a bouncing boy, and the second.

MR. CHAS. A. WHITE, president of the Bibber-White Company, Boston, has had additional dignity placed upon him, having been unanimously elected president of the Board of Aldermen of Malden, Mass., his place of residence.

DESTROYED BY FIRE.—The factory of the Consolidated Insulated Tube Company, Boston, Mass., was destroyed by fire a few days ago. This company manufactures high-grade insulated conduits, brass and iron armored, and its office is in the John Hancock Building.

MUNICIPAL OWNERSHIP OF STREET RAILWAYS.—The Board of Aldermen of Boston are agitating the question of municipal ownership of the West End Street Railway Company, and have gone so far as to pass a vote to appeal to the Legislature with regard to its purchase.

MR. F. B. SMITH, vice-president and general manager of the Paragon Arc Lamp Company, Boston, is making a brief trip west in the interests of his company. Mr. Smith is an indefatigable worker, and his active efforts, together with those of Treasurer J. R. Hammer, are already creating a promising business outlook for the Paragon arc lamps.

THE CLIFTON MANUFACTURING COMPANY, Boston, manufacturer of the Clifton Fireproof Insulating Conduit, has, with the advent of 1897 made for itself a very important acquisition in the person of Mr. George F. Virtue who will hereafter conduct its conduit and electrical specialties department Possessed of extended practical experience, particularly in conduit manufacture, and also of exceptional business energy and ability, Mr. Virtue will unquestionably materially increase the business of the Clifton Company in the electrical field. The Clifton Company is about building a new and separate factory for its conduit manufacture and rubber specialties for electrical work. The Clifton insulating conduit has the approval of the National, Boston and New York Board of Fire Underwriters, and also of the New York fire department.

THE H. N. BATES MACHINE COMPANY, Boston, with the beginning of 1897, announces a change in its executive management as follows: Mr. L. I. Fletcher succeeds as treasurer Mr. H. N. Bates and Mr. F. H. Bates becomes the secretary of the company. Mr. H. N. Bates remains a large stockholder in the company and it will continue to have the benefit of his wise counsel and influence, but other interests of his demand considerable of his attention; hence he withdraws from the company the activity which he has hitherto taken. The company is to be congratulated in bringing Mr. Fletcher into more intimate contact with its general business, as he is abundantly possessed of excellent executive ability, which will undoubtedly tell for its machinery branch as much as it has for its electrical apparatus manufactures, to take care of which became necessary the magnificent new factory of the company at Nashua, N. H. Mr. F. H. Bates is a brother of H. N., and has had much to do with the active business of the company, and richly deserves the position of secretary.

WESTERN NOTES.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, ILL., Jan. 12, 1897.

FALSE REPORT.—A report was circulated a few days ago to the effect that the Western Union Telegraph Company had purchased the Western Telephone Construction Company. Mr. J. A. Keelyn, president of the latter company, informs us that the report is not true.

EUGENE MUNSELL & CO., Chicago, miners and importers of mica, announce that they have moved into their new quarters at 117-119 Lake Street. The increased facilities for handling their western business will enable them to carry a larger stock of mica and drop forged copper segments, and thus place them in a position to fill all orders promptly.

THE AMERICAN RHEOSTAT COMPANY, Milwaukee, Wis., is busy putting in more machinery and otherwise increasing its facilities in order to enable it to keep up with its orders. The business manager of the company, Mr. Frank R. Bacon, is the son of Milwaukee's largest grain merchant, Mr. E. P. Bacon. He is also connected with the firm of E. P. Bacon & Co.

MR. T. C. RAFFERTY, who is probably one of the best-known men in the electrical supply business in the country, is now associated with the Metropolitan Electric Gompany, Chicago, having disposed of all his other electrical interests. All of Mr. Rafferty's friends and customers will undoubtedly be pleased to learn of his new connection, which will afford him ample scope for his energetic work, enabling him to take care of his customers' wants in a befitting manner and renew old and pleasant trade relations.

MR. CHARLES DAVIS, president of the Davis & Egan Machine Tool Company, Cincinnati, O., has just returned from a six months' trip to Europe, where he visited Russia, Germany, France, Austria, Norway, Sweden, Belgium, Holland, Denmark and England, establishing agencies in all the large cities in these countries. He secured many large orders direct from the consumers, and as a result of his trip the company is now working nearly 600 men 12 hours per day, and has orders on its books to keep it running full force until the 1st of May.

HONOR TO WHOM HONOR IS DUE.—Mr. J. M. Hill, the Chicago representative of the Wagner Electric Manufacturing Company, St. Louis, also manager of the Columbia Incandescent Lamp Company of the same city, has received from Hon. Mark A. Hanna a personal letter, in which the writer extends the thanks of the National Republican Committee for the success of the work of Mr. Hill in connection with the political parade in Chicago on Oct. 9 last. One of the electrical features of this parade, it will be remembered, consisted in applying the long-distance telephone for the purpose of transmitting to distant cities the sounds of the cheers of the people and of the music of the bands along the line of parade. There seems to have been some controversy as to where the idea originated and from information obtained the credit evidently belongs entirely to Mr. Hill. The electrical feature was carried out on the lines of Mr. Hill's original suggestion and was an unqualified success.

THE ELECTRICAL EXCHANGE.—This concern has at its new establishment about 4000 square feet of floor space. Of this the offices occupy 1000 square feet, the remainder of the store being devoted to store room and repair shops. The store is lighted by gas and electricity. It is the intention of the Exchange to carry at all times a full line of electrical supplies and a good stock of electrical machinery. It also intended to develop its repair shop to the greatest extent, and with this end in view, is adding new machinery and putting the same in charge of competent men. In June last the Exchange purchased the entire stock of electrical supplies of the Jones Bros. Electric Company, Cincinnati, O., and in December it bought the stock of the New York Electric Company, Youngstown, O., which consisted of something like 30,000 incandescent lamps. The Electrical Exchange was incorporated Nov. 1, 1896, and the president of the company is C. L Glasner, Mr. T. S. Lane being the secretary and treasurer. The business is at the present time in a flourishing condition, and the Exchange has about all it can handle, but its intention is to largely increase its facilities during the coming year.

ST. LOUIS NOTES.

ST. LOUIS, Jan. 12, 1897.

THE KINLOCH TELEPHONE COMPANY.—The failure of the "Sutter" bill to pass the City Council over the Mayor's veto will not affect the progress of the Kinloch Telephone Company. It will go right along like the other companies under the "Keyes" conduit bill.

NEW TERRITORY.—Several proposed extensions are contemplated by the various street railways in the Spring, to be finished during the Summer. The Lindell system is contemplating the extension of three of its lines, the Payne, Taylor and Spaulding Avenues. The suburban line is to be extended several miles along Union Avenue. The Citizens' line is to be extended to St. Charles.

NEW ELECTRIC LIGHT PLANT.—It is reported that the plant for the South Broadway Merchants Association is an assured fact. The merchants on South Broadway are dissatisfied on account of the Missouri Electric Light Company doubling its price for light when used in conjunction with gas. This action spurred the merchants on in organizing. The plant will be on the co-operative plan, and the association proposes to capitalize for $50,000.

WANTS TO SELL OUT.—It is rumored that the People's Railway Company—The Fourth Street cable line—is for sale. Negotiations have been opened with New York parties. Mr. Thomas C. Barr, a street railway magnate of Newark, N. J., is said to be the party, and he is expected in St. Louis to make a personal inspection. The proposed deal will include the Fourth Street and Arsenal Railway. If it is made both roads will be operated as one system, and be supplied with electricity from one power house.

CABLE RAILWAY CONDUIT AS AN ELECTRICAL CONDUIT.—Charles Green, president of the People's Railway Company—the Fourth Street Cable line—announces that his company will lease the use of its conduit, which carries its cable from Fourth and Niagara Streets to Lower Grove Park, 10 miles, to the electrical company making the most advantageous offer. As the directors of the street car company contemplate in the near future changing the motive power of the road to electricity, the conduit will have to be abandoned, hence the proposition.

COMPROMISE OR NOTHING.—According to J. D. Houseman, Jr., the 60 people who were more or less injured by the collision on the Kirkwood Electric Road last Spring must either accept a compromise or the road will default on its bonds. The bondholders will foreclose and the injured ones will get nothing. Ten thousand dollars is the amount proposed to be divided. If the case is not settled the St. Louis Trust Company, as trustees for bondholders, will advertise the road for sale about Jan. 20. In that case the only recourse will be to bid the road in, which will cost about $300,000.

TRYING TO HEAD OFF RINGSTERS.—There is a great deal of interest shown in the lighting contract. The only way to prevent the city from being held up will be to make it easy for outside companies to come in and compete, thereby preventing combinations of local companies. The policy of the local companies is to delay matters, for they see that if the award can be delayed they can be able to fix the Municipal Assembly. The members of the Board of Public Improvement know this, so they fixed the date for awarding the contract on Dec. 9. The contract and specifications have been drawn with great care, in anticipation that an attempt will be made to have the successful bid thrown out on the ground of some trifling defect.

CANVASSERS OUT.—The Kinloch Telephone Company has commenced operations and has opened offices in the Wainwright Building. Fourteen clerks and draughtsmen are employed, and a force of 50 canvassers are out soliciting patronage from citizens. The offices are in charge of Hopkins J. Hanford, general manager of the company, who is supervising the drawing of the plans for the new telephone plant. Fifty thousand letters enclosing blank form contracts have been mailed. There are three forms. The first is for private residences, at $36 per year; physicians, $50 per year, and business houses, $60 per year. The company intends to have the plant ready for operation within 18 months, and if possible sooner. Work will be commenced in a few weeks and pushed rapidly.

PACIFIC COAST NOTES.

SAN FRANCISCO, CAL., Jan. 11, 1897.

THE REGER-ATWATER COMPANY, San Francisco, recently took the agency for the Monarch insulating paint, manufactured by the Bradford Belting Company, Cincinnati, O.; also the agency of the Western Gear Company, Milwaukee, Wis.

THE ELECTRICAL ENGINEERING COMPANY, San Francisco, recently shipped from its factory to E. W. Chapman, owner of the Zantgraf mine in El Dorado County, Cal., a 50-hp double-reel hoist. It weighs over 20,000 pounds and will be driven by a 50-hp generator of the same make. During the past year this company built 26 electric elevators which are now in operation in San Francisco and other cities in California. The company's latest passenger elevator has just been installed in the new six-story McCarthy Building on Market Street. It is a double-worm equipment, driven by two 15-hp motors.

THE PACIFIC POWER COMPANY has just put into operation, at its works in San Francisco, a 300-hp Walker generator, which is operated by a 500-hp Willans central-valve triple-expansion engine. Salt water is pumped from the bay for condensing, in which the Goubert surface condenser is employed with Snow steam pumps. Several additional factories are now being operated on the circuits of the new generator. It lights the *Daily Examiner* offices,

where it also operates a 108-hp Edison motor. Over 50 factories are successfully run from the company's system, which includes many miles of underground conduits. Ira Bishop is superintendent of this company and also manager of the Piedmont & Mountain View Railway Company.

CANADIAN NOTES.

MONTREAL, CAN., Jan. 8, 1897.

BIDS INVITED.—Tenders for lighting the streets of Paris, Ont., by 25 or 30 arc lights are invited. Address S. Dadson, Town Clerk, for further particulars.

STREET RAILWAY EARNINGS.—The Toronto street railway earnings for 1896 are announced to be $986,501, of which the city share is $78,921, a slight increase over the figures of last year.

MUNICIPAL PLANT AT CHATHAM.—The question of installing a civic electric light plant is under consideration by the City Council. The present contact for lighting expires in September, 1897.

TO BE MADE A TROLLEY LINE.—The owners of the Berlin Electric Railway are said to be negotiating with Col. Stacy for the purchase of the street railway in St. Thomas. Should the deal be consummated, it is proposed to introduce electric power.

THE INTERNATIONAL RADIAL RAILWAY COMPANY has asked the City Council of Hamilton, Ont., for a bonus of $65,000, to help build a road from Hamilton to Guleph. This electric road will be one of the many links connecting the city with nearby places. It is understood that the Council is favorably inclined to grant the bonus.

PROPOSED CONSOLIDATION OF HAMILTON ROADS.—A scheme is on foot to amalgamate the electric railways in and around Hamilton, in which case the Hamilton & Dundas Railway will be converted into an electric road and extended to Galt, while the Radial Railway will be extended to Oakville and later to Mimico.

THE HURON & ONTARIO ELECTRIC RAILWAY, which is to run from Kincardine, Ont., and Goderich, *via* Walkerton, thence north to Meaford and south to Port Perry, is to be built at once. The New York contracting firm states that it will be finished by January, 1898. A meeting of the provisional directors to ratify and sign the contracts will be held in a few days.

PROPOSED IMPROVEMENTS.—The dispute between the directors of the Niagara Central Railway Company is likely to be satisfactorily settled, when the movement will be made to introduce a suburban service between St. Catherines and Niagara Falls. This service will necessitate the rebuilding of the road and repairing of the present rolling stock. Plans for the scheme are already being considered and the work will probably soon commence.

THE GENERAL ELECTRIC COMPANY of Canada, has won its suit against the town of Port Arthur. The town purchased a quantity of electric railway equipment from the General Electric Company. The town in part payment gave a promissory note for $1747.20 and interest. The town repudiated the note and when sued, set up a counter-claim of $10,000 damages. Judge Rose dismissed the counter-claim and rendered a decision favorable to the electric company.

SEEKING A FRANCHISE.—Application is being made to the Ontario Legislature by Alexander H. Edwards, of Carleton Place; John B. Riley, of Plattsburg, N. Y., United States Consul General at Ottawa; Thomas Henry, of Montreal, and James Fowler, of Arnprior, for an Act to incorporate the Lanark County Electric Railway Company, with power to construct a line of railway from the town of Perth to the village of Lanark, and to extend the same to Olivers Ferry and Smiths Falls on the south, and to Almonte and Carleton Place on the north.

OTTAWA, Jan. 9, 1897.

LARGE DYNAMOS.—The Ottawa Electric Railway Company is gradually replacing its smaller dynamos with larger ones. In No. 5 power house, eight of the dynamos have just been replaced by one with 1000-light capacity. This is perhaps the largest one in Ontario.

THE PACIFIC CABLE.—Members of the Dominion Government refuse to say anything about the report of the Pacific Cable Commissioners, which has just been signed in England, but it is understood to give the cost of construction and to recommend that the work be done by Britain and the different colonies interested. An estimate of what the mother country and the colonies should each pay towards the scheme is also given. The exact provisions of the report will not be made known until such time as it has been received by the different Governments who are interested.

General News.

NEW INCORPORATIONS.

THE ROLLA ELECTRIC LIGHT COMPANY has been incorporated at Rolla, Mo., with a capital stock of $3,500. Those interested are Henry Bedlow and A. S. Long.

THE LOMIRA TELEPHONE COMPANY has been incorporated at South Bend, Wis. The incorporators are Dr. Baker, W. Thalen, W. Hoppe and H. W. McCarthy.

THE ELECTRIC TIRE WELDING COMPANY, Detroit, Mich,, has been incorporated by C. L. Coffin, C. E. Lathrop and C. V. Carson. The capital stock is $200,000.

THE BELOIT ELECTRIC LIGHT & POWER COMPANY, Beloit, Wis., has been organized by G. L. Cole, A. F. Spaulding and R. J. Burdge, with a capital stock of $25,000.

THE ADVANCE ELECTRIC COMPANY, Indianapolis, Ind., has been incorporated with a capital stock of $5000. Those interested are Henry B. Marsh, David B. Smith and Charles H. Talmage.

THE UPPER SANDUSKY TELEPHONE COMPANY has been incorporated at Upper Sandusky, O., by M. H. Brinkerhoff, G. W. Hale, C. D. Juvinell, Anna E. Osborn and T. E. Berry. Capital, $12,000.

THE VAN WERT HOME TELEPHONE COMPANY, Van Wert, O., has been formed by G. M. Saltzgeber, H. Kewper, George W. Kohn, John Van Lien and W. H Pennell. The capital stock is $25,000.

THE GENEVA TELEPHONE COMPANY, Geneva, N. Y., has been incorporated with a capital stock of $6000. The incorporators are Frederick S. Bronson, Charles H. Stearns, MacG. Converse and others.

THE WINDMILL ELECTRIC COMPANY, New York, N. Y., has been incorporated with a capital stock of $100,000. Those interested are W. S. Townsend, R. D. Lankford, of Brooklyn, and R. J. Henderson, Newark, N. J.

THE VICE VERSA ELECTRIC LAMP COMPANY, of New York City, has been incorporated with a capital stock of $5000. Those interested are Joseph Worth, Maurice B. Haeymn and George W. Gorton, of New York City.

THE COMPRESSED AIR POWER COMPANY, New York, N. Y., has been organized with a capital stock of $1,000,000. The directors of the company are William C. Whitney, Thomas J. Ryan, Frederick S. Pearson, William W. Cook and William L. Elkins.

THE MONTEVIDEO ELECTRIC LIGHT & POWER COMPANY has been organized at Montevideo, Minn., by A. T. Teisberg, of St. Paul; George C. Knocks and Joseph C. Littelson, of Minneapolis; C. A. Fosnes, L. R. Moyer and P. L. Norman, of Montevideo.

THE GREENBUSH & NASSAU ELECTRIC RAILWAY & POWER COMPANY has been formed at Greenbush, N. Y., by William H. Nichols, John F. Lape and others of Greenbush. The road will be 17 miles long and will run from Greenbush to Brainerds.

TELEGRAPH AND TELEPHONE.

OTTAWA, O.—There is some talk of building a telephone line between Rice and Defiance, O.

KEOTA, IA.—A company has been organized in this place to build a telephone line from here to Richmond.

TRENTON, MO.—It is stated that a new telephone line is to be built from Chillicothe to Trenton through Farmersville.

SHULLSBURG, ILL.—The new telephone system has been completed here, placing Shullsburg in direct communication with several adjoining towns.

WARREN, O.—The people of Bristolville are anxious to have telephone connection with Warren and the surrounding towns, and are agitating the question.

MARSHFIELD, WIS.—Mr. James A. Gaynor, of Grand Rapids, is taking steps looking to the building of a telephone line between Marshfield, Grand Rapids and Centralia.

CORPUS CHRISTI, TEX.—Work on a long-distance telephone line to connect this place with Brownsville has been commenced, and will be pushed rapidly to completion.

KNOXVILLE, TENN.—The People's Telephone Company has just completed a line into Blount County, thus placing Knoxville in direct communication with Rockford, Louisville, Friendsville and Holston College. The new line is 24 miles in length.

DECATUR, ILL.—The Interstate Telephone Company has completed arrangements to carry its lines into Bement. This company will connect with all the points in the central part of the State, and it expects to have the line from Tolono to Decatur in operation within a month.

DELAWARE, O.—Messrs. E. G. Lyman, L. P. Lewis and Hon. H. S. Culver, all of this city, have been granted a franchise by the City Council for the construction of a telephone exchange here. Work will be commenced at once. The new concern will be in opposition to the Bell Company.

ADRIAN, MICH.—A telephone line will be constructed from this city to Wauseon, O., and it will connect with all the principal towns in Northwestern Ohio and Northern Indiana. The main office will be in Adrian, and it is expected that the local exchange will be completed by February. The company is composed of Wauseon gentlemen.

INDIANAPOLIS, IND.—A dispatch from Wabash, Ind., states that the Western Union Telegraph Company's manager at that place has received instructions from headquarters to take telephone service from the lines of the Home Telephone Company, the old telephone contract having expired. This is stated to be the first instance where telephone messages have been received by the Western Union Company over wires of a rival of the Bell Company.

DETROIT, MICH.—Jan. 30 is the date set for the opening of the Detroit Telephone Company's new plant. It is stated that 1000 buildings have been wired, and the company claims that it has over 5300 subscribers. The city, according to the franchise, will have the free use of 75 instruments, and it is proposed to connect a large number of schools with the offices of the Board of Education, after the plan adopted in the case of the police stations. In this way the schools now widely separated will be brought more directly under the supervision of the superintendent.

ELECTRIC LIGHT AND POWER.

BAINBRIDGE, GA.—S. Nussbaum is in the market for an electric plant.

BYRON, MICH.—Byron is to have an electric light plant in the near future.

CAZENOVIA, N. Y.—The question of electric lighting is being considered in this place.

SPARLAND, Ill.—The citizens of Sparland are agitating the question of electric lighting.

LAURENS, S. C.—The city has sold $30,000 water and light bonds. Bids will soon be received.

WOODSTOCK, VA.—L. W. Brown is seeking a franchise to establish an electric lighting plant.

MEDFORD, MASS.—The establishment of a municipal electric light plant is being agitated at this place.

NORTH BRANCH, MICH.—The question of installing an electric light plant here is being agitated.

BLUFFTON, O.—The proposition was carried to issue $8000 in bonds for the construction of an electric light plant.

CUMBERLAND, MD.—A vote is to be taken to decide whether or not the city is to issue bonds to go into the street lighting business.

MORRISVILLE, N. Y.—The electric light plant in this place, which was recently destroyed by fire, is about to be replaced by a new one

WEST SPRINGFIELD, MASS.—The citizens of this place are considering the question of municipal ownership of the electric light plant.

JEANNETTE, PA.—It is stated that the work of constructing an extensive electric lighting plant here will be commenced in the early Spring.

MILWAUKEE, WIS.—The village of South Milwaukee has decided to purchase the electric light plant of William Williams and operate it itself.

LEBANON, O.—The Council is considering the matter of establishing a municipal lighting plant The contract with the electric light company expires in June.

SISTERSVILLE, W. VA.—It is proposed to organize a company to put in an electric light plant. A. C. Jackson, cashier of the Tyler County Bank, is interested.

THORPE, WIS.—Henry Leoble, of this place, has been granted a franchise for building and operating an electric light plant. Work will begin on the same at once.

CORTLAND, N Y.—Mr. John Hamlin, for several months superintendent of the Cortland & Homer Electric Light Company, is about to start a new electric plant in Cortland.

SOUTH NORWALK, CONN.—The General Electric Company, which controls the electric light plant here, has been awarded the contract for lighting the city at $74 per light a year.

HUDSON, MASS.—At the town meeting it was voted to appropriate $20,000 for the purchase of the Hudson Electric Light Company for the purpose of establishing a municipal lighting plant.

BAY SHORE, L. I., N. Y.—A stock company to build a plant for the lighting of the village is now in process of organization. Directors: William Wallace, Spencer Aldrich, Josiah Robbins and others.

PITTSBURG, PA.—During the coming session of the Legislature, an appropriation of $36,000 will be asked for to be utilized in erecting an extensive electric light plant, for lighting Riverside Penitentiary.

COLLEGE POINT, L. I., N. Y.—The Flushing Electric Light & Power Company has made application to the Board of Village Trustees for permission to erect poles and introduce electric lights in this village.

NEW BRIGHTON, PA.—A movement is on foot for the erection by the borough of an electric light plant. The proposed new plant would be for 100 lamps of 1200 candle-power, and it is estimated that it could be built for $20,000.

SHARON, PA.—Sharpsville Council granted Robinson Bros. the right of way to erect poles in the borough, for the purpose of furnishing electric light, heat and power to the town. They will begin the erection of a new building immediately, to cost $10,000.

CHICAGO, ILL.—The Council Finance Committee recommended the appropriation of $22,250 to change the motive power of the bridges in the downtown district from steam to electricity at the request of Commissioner of Public Works. It is estimated that $1700 a month will be saved by operating the bridges by electricity.

POUGHKEEPSIE, N. Y.—Mayor Hull is of the opinion that the time has come for the City of Poughkeepsie to own its own electrical plant. He has submitted a special message on the subject to the Common Council, which includes an estimate for building a plant, the price being $82,221. He figures that the city would be a gainer of $12,000 a year by the operation of its own plant. A committee has been appointed to investigate and report.

The Electric Railway.

ALLEGHENY, PA.—The Pittsburg & Allegheny Central Railway Company and the Evergreen & Hamlet Street Railway Company are seeking a franchise.

CHARLESTON, S. C.—The City Street Railway Company will apply for a 50-year extension of its charter. It is proposed to entirely remodel its present system.

CHAGRIN FALLS, O.—The building of an electric railway between Cleveland and this place by the Cleveland & Chagrin Falls Electric Railway Company is now said to be assured.

BURLINGTON, VT.—It is reported that the Burlington capitalists will begin to build an electric road from Saxton's River to Bellows Falls, in the Spring. Among those interested are J. J. Flynn, F. C. Kennedy, J. S. Pearson, A. O. Humphrey and J. H Holton.

WILLOUGHBY, O.—Work will be started at once on the erection of car houses at Willoughby to take the place of those destroyed by fire. The loss on the houses and four cars which were destroyed will not exceed $40,000, the entire loss being covered by insurance.

NEW HAVEN, CONN.—The trolley company projecting an extensive system of new lines at Milford, Conn., will petition the Legislature for permission to connect with the Bridgeport Traction Co.'s lines, which would form a parallel of the steam road between Milford and Bridgeport.

PORT CHESTER, N. Y.—The Port Chester Railway Company, which recently received a franchise for a road through the village, has also received a franchise for a road to Greenwich and another to Glenville, and will make an effort to get a franchise to White Plains, Rye and Mamaroneck.

YOUNGSTOWN, O.—The Mahoning Valley Electric Railway Company has placed a mortgage on record to the Central Trust Company of New York, for $1,200,000. The amount will be used in taking up bonds and making extensive improvements to the line through the city and extending to Niles.

CORTLAND, N.Y.—It is reported on good authority that the directors of the Cortland & Homer Traction Company are perfecting plans to extend the electric line from McGrawville east through the towns of Solon, Willet, Taylor, Pitcher to Cincinnatus. The company expects to make a survey at once.

KITTERY, ME.—Several Massachusetts capitalists have purchased the franchise of the Kittery, Kittery Point & York Beach Electric Railroad Company, and the work of construction will be commenced at once. An attempt is being made to acquire possession of the Portsmouth electric railway franchise.

KANSAS CITY, MO.—It is probable that the electric line on Wyandotte Street, from the Grand Central Depot to the Southwest Boulevard, thence to Rosedale, will be in operation by July 1. The West Side Street Railway Company formally accepted the franchise recently granted by the Council for the construction of three lines.

SAVANNAH, GA.—The property of the electric railway company was sold at auction on Jan. 5, by the United States Marshal, for $210,000. The purchasers were Herman Myers, of Savannah, and John H. Hall, of Nashville, representing a syndicate of New York bondholders. The company will be reorganized and a large amount of money spent for new equipment.

GLENS FALLS, N. Y.—There are said to be prospects of the Glens Falls, Sandy Hill & Fort Edward Street Railroad Company extending its lines through Glens Falls streets and to Lake George and Warrensburg. Engineers are surveying the streets of Glens Falls. The feasibility of constructing the lines will be considered when the engineers submit information.

NEWARK, N. J.—The Belleville Township Committtee has granted to the Passaic & Newark Electric Railway Company the privilege to construct and maintain an electric railway between Jerolemon Street and the northern end of the township line. This action, it is stated, practically terminates the fight between the Township Committee and the railway company, which has lasted over two years.

ELECTRIC ROAD FROM OLEAN TO BRADFORD.—The Olean, Rock City & Bradford Electric Railway Company is about to incorporate with a capital stock of $100,000. The principal promotors are H. L. Pierce, of Leominster, and Frank E. Lowe, of Greenville, Mass. The plan is to use the right of way of the W. N. Y. & P. narrow gauge road over the hills. A large hotel and several cottages will be erected for use of Olean and Bradford people at Rock City, which will be developed as a summer resort. This will practically convert into a trolley system the 22 miles of narrow guage road owned by the Western New York & Pennsylvania system.

SPRINGFIELD, MASS.—It is stated that the proposed electric railway to the summit of Mt. Tom will be constructed in the Spring and put into operation by June next. The project calls for the expenditure of $100,000 or more for the construction of the incline up the mountain. The road will run diagonally up to the south point of the mountain and will be about a mile in length, the rise in that distance being about 700 feet. The motive power will be electric, and the cars will be operated on the balance principle, similar to that used on the Catskill mountain line. While one car runs up the other comes down, both being attached to a cable which will pass over big drums at either end of the line.

THE AUBURN & WESTERN RAILWAY COMPANY was incorporated in Cayuga, N. Y., on Jan. 7, to operate a trolley line between Auburn and Seneca Falls. It is intended to build a line at the side of the road running from Auburn to Cayuga Village, thence by bridge across Cayuga Lake, a distance of a little over a mile, thence by road to Seneca Falls. The franchises of the company cover the entire route, which is about 11 miles in length. The capital stock of the company is $300,000, and the directors are Robert Wetherill, Chester, Pa.; W. C. Gray, Jr., and N. H. Beilser, of Seneca Falls; George B. Longstreet, Auburn; George B. Leonard, William P. Goodelle, W. A. Holden, H. W. Plumb and C. D. Beebe, Syracuse. These gentlemen own a controlling interest in the Auburn City Railway Company and the Geneva, Waterloo, Seneca Falls & Cayuga Lake Park Traction Company, which latter is 12 miles in length.

Legal Note.

THE SYRACUSE STORAGE BATTERY CO., Syracuse, N. Y., it is reported has passed into the hands of a receiver. This company was incorporated in 1892, and has operated under a license from the Electric Storage Battery Company, Philadelphia. The paid up capital is $300,000. The assets are said to be $30,000 and the liabilities $40,000. The reason given for the appointment of a receiver was that the company could not realize enough from outstanding accounts.

Personal Notes.

MR. W. BARCLAY PARSONS, chief engineer of the Rapid Transit Commission, has been elected a member of the Board of Trustees of Columbia University, to fill the vacancy caused by the death of the late Joseph W. Harper.

MR. MATTHEW MELVILLE MERRITT, of the Merritt Electric Company, Middletown, Conn., was on Jan. 20 united in marriage to Miss Anna Pettengill, niece of Mr. and Mrs. H. J. Pettengill. Boston. The ceremony took place in the Universalist Church, in Melrose, Mass. The bride's uncle, Mr. H. J. Pettengill, is president and general manager of the Merritt Electric Company, also superintendent of the first district of the Postal Telegraph-Cable Company.

HONORS FOR DISTINGUISHED SCIENTISTS.—The Russian Academy of Science at St. Petersburg has elected as honorary members of that body Lord Kelvin, professor of natural philosophy at the University of Glasgow, and Lord Rayleigh, scientific adv sor of the corporation of Trinity House, London. Prof. Simon Newcomb, the American astronomer, who lives in Washington, D. C., also received the same honor from the same society.

Trade and Industrial Notes.

THE ARMORITE INTERIOR CONDUIT COMPANY, Detroit, Mich., announces a reduction in prices for "Armorite" conduit and fittings. The company is enjoying a very active business.

MILLING MACHINES.—The Cincinnati Milling Machine Company, Cincinnati, O., describes its improved milling machines in a very neat catalogue just issued. The illustrations are very artistically rendered

MR. M L. LIVINGSTON, assistant manager of the Standard Thermometer Electric Company, Peabody, Mass , has been spending a week in New York. He reports having met with gratifying success in placing his company's new arc lamp before the trade, and is receiving therefor some satisfactory orders.

ELECTROMAGNETIC RAILWAY SYSTEM.—The Osborne Electromagnetic Railway System, Auburn, N. Y., has issued a pamphlet giving a brief description of what is claimed to be a new, simple, successful and safe system for operating street cars by electricity without the use of overhead trolley wires.

T. J. MURPHY & CO., recently assigned, will be pleased to answer all inquiries addressed to either T. J. Murphy or J. F. McGuire, No. 511 West Thirteenth Street, New York, pending settlement of the firm's affairs. Mr. Murphy expects to soon reorganize the business and continue in the same line, with better facilities than before

THE DAVIS & EGAN MACHINE TOOL COMPANY, Cincinnati, O., has just issued a complete catalogue showing its line of machine tools. It is standard size, 9 in. x 12 in. The company has secured the premises on Sixth Street, opposite its present factory, and will at once begin the erection of a fine warehouse thereon. The new building will be completed in about two months.

WATER POWER.—The S. Morgan Smith Company, York, Pa., manufacturers of turbines, power transmitting machinery, boilers, etc., is engaged in the preparation of drawings for the improvement of four water-powers, which aggregate over 100,000 horse-power. The company reports that its foreign trade still keeps good, with prospects for an increase in the near future.

THE MICA INSULATOR COMPANY, New York, Chicago and London, announces that it has removed its western headquarters to 117–119 Lake Street, Chicago, and is in a position to fill promptly all orders for its micanite specialties. During the past year the company has enjoyed an increased trade in the west among the electrical manufacturers, electric railways, and lighting companies.

IMPORTANT CONTRACT.—The contract for the complete rolling stock of the Quebec Electric Railway, including cars, motors, etc., has been awarded to Ahearn & Soper, Ottawa, Ont. The system at Quebec will be as nearly as possible a duplicate of that at Ottawa, which is recognized as a model. The motors used will be of the Westinghouse make, and will be specially adapted for the grades which exist at Quebec.

THE STANDARD AIR BRAKE COMPANY, New York, has received an order from Germany for air brake equipments for 30 double-truck motor cars for the Oberschlesische Dampfstrassenhahn. The order for 30 additional equipments is expected to follow. The road on which this apparatus is to be installed is an old steam line converted to the electric faith. The Standard Company's foreign trade is reported to be very active.

MR. C M. TURNQUIST, 216 South Clark Street, Chicago, dealer in general electrical supplies, has issued a little book entitled "Electric Bell Hanger's Guide." It gives a price list of electrical supplies dealt in by Mr. Turnquist. Valuable diagrams showing bell circuits of all kinds are given, and these, no doubt, will afford much aid to those engaged in this branch of electrical work. Mr. Turnquist carries a line of general electrical supplies, tools, wire, etc., used by electricians, bell hangers, experimenters, inventors and amateurs

MESSRS. J. JONES & SON, 69 Cortlandt Street, New York, report the new year opening well up in good orders They have one for a switchboard with capacity of 800 amperes for a New Jersey town; another for a hospital plant, and a third going into a theatre. They have just completed an order for 10 panel boards having a capacity of 2000 amperes with the main board for the same plant. They also report two foreign orders for their specialties, wire winders, measurers, reels and tank alarms, with a third for a heavy shipment of line wire.

PACKARD LAMPS.—Notwithstanding the advance in the selling price of the standard makes of lamps, made necessary largely by the fact that the manufacturers have been operating under an actual loss for the past two years, the Electric Appliance Company, Chicago, reports that the sales of Packard lamps have increased since the time of the advance, showing that its customers appreciate a good thing, and are willing to pay a fair price for a first-class article. The Packard lamp business has always been a very satisfactory part of the Electric Appliance Company's trade.

PROPOSALS.—Sealed proposals and bids will be received by the Allen County Board of Commissioners at Fort Wayne, Ind., up to 2 p. m., on the 25th day of February next, for furnishing, among other things, electrical construction, including wiring of sheriff's residence, jail, and power station; telephone system and electric elevators, automatic time system, engines and dynamos, and also alternate proposals for Corliss engines, belting and dynamos, power-station and stack. Further particulars may be obtained from the Board of Commissioners of the County of Allen, Fort Wayne, Ind.

THE PHILADELPHIA ENGINEERING WORKS, LTD., Philadelphia, Pa., has issued a neat pamphlet on the subject of its steel plate chimneys. The advantages of this method of construction of chimneys are set forth, and some valuable information on the subject is given. The pamphlet contains several illustrations of examples of the company's work in this particular direction, one of the chimneys so represented being 217 feet in height. The Philadelphia Engineering Works manufactures the well-known Philadelphia water-tube safety boiler, and carries on a general business in the manufacture of iron tanks, stand pipes, steel buildings, blowing machines, air and gas compressors, etc.

THOS. J. FAY & ASSOCIATES, 143 Liberty Street, New York agents and general exporters for the Crocker-Wheeler Electric Company, have been awarded the contract for the ventilating motors to be used in Mr. John Jacob Astor's new hotel, as follows: two 24-hp motors, maximum speed 190 r. p. m.; one 30-hp motor, maximum speed 140 r. p. m.; one 32-hp motor, maximum speed 175 r. p. m.; one 40-hp motor, maximum speed 115 r. p. m.; one 60-hp motor, maximum speed 175 r. p. m.; one 90-hp motor, maximum speed 140 r. p. m These motors will be direct connected to exhausters and blowers, and the plant is thought to be the largest and most complete electrical equipment for ventilating work ever let.

MR. CAMPBELL SCOTT, for the past two years general manager of the Louisville Electrical Works, having disposed of his interest in this concern, is now located at Atlanta, Ga., where he is in charge as manager of the Southern office of the C & C Electric Company of New York City. The C & C company proposes to enter the Southern field for its share of the electrical business there, and has established the Atlanta office at 630 Equitable Building, under the management of Mr. Scott as the headquarters for the territory south of the Ohio and east of the Mississippi Rivers. The long experience of Mr. Scott in the electrical business and the merits of the C & C Company's apparatus will no doubt meet with their just rewards in the shape of a large business.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company 67–71 Park Place, New York City.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, 105 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED JAN. 5, 1897.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

574,370. MANUFACTURE OF INCANDESCENT ELECTRIC LAMPS; T. B. Atterbury, Pittsburg, Pa. App. filed Dec. 18, 1894. The method of making incandescent lamps, consisting in cementing an unground perforated stopper in the lamp by vitrifiable enamel or cement and then heating to vitrify said enamel.

574,377. ELECTRIC RAILWAY TROLLEY; E. M. Bentley, New York, N. Y. App. filed July 28, 1896. The combination in an electric railway contact device of a supporting arm upwardly spring pressed, a guide way on the outer end of said arm, a pivoted tip or end section movable on said guideway, a contact wheel on its outer end and a spring for pressing said wheel into engagement with the line conductor.

574,388. ELECTRIC PROPULSION OF VEHICLES; W. A. Butler, New York, N. Y. App. filed May 19, 1895. The combination with an overhead structure, consisting of uprights and cross-beams, positive and negative distributing conductors supported at intervals by and above the cross-beams and insulated between such points of support, a series of contact-rollers for each conductor, each permanently electrically connected with it and located beneath one of such cross-beams, a track or way running parallel with the lines in which such contact-rollers are arranged, vertically-yielding elongated contact-shoes, one for each series of rollers, carried by a vehicle traveling upon such track or way, and circuit connections extending from each shoe to the vehicle, the organization being such that each shoe makes contact with one of the rollers of its series before leaving another.

574,417. SECONDARY BATTERY AND PROCESS OF FORMING SAME; G. W. Harris and R. J. Holland, New York, N. Y. App. filed Jan. 30, 1896. An electrode formed of a single integral piece of lead, for use in secondary or storage batteries, and consisting of an open work or skeleton plate composed of oppositely inclined intersecting or crossing ribs and grooves on its opposite sides, said ribs being of rectangular or quadrilateral form in cross-section and the said grooves on one side of the plate extending to the grooves on the opposite side thereof, and all of said grooves being open at the side and bottom edges of the plate to make the latter borderless, except at its top, where it is provided with a lug.

574,430. SUBWAY CONDUIT; W. H. Johnston, St. Louis, Mo. App. filed Aug. 15, 1896. In a conduit for electrical conducting wires or cables, the combination with main or cable ducts, of distributing ducts, a guideway centrally disposed with relation to said distributing ducts, a block adapted to slide back and forth in said guideway, arms mounted upon said block and extending into each of said distributing ducts, to which arms may be secured wires which it is desired to draw through said distributing ducts, ropes attached to either end of said block to draw it through the guideway in either direction.

574,527. SELF-ADJUSTING TROLLEY WHEEL; G. W. Duryea and T. W. Thompson, Brooklyn, N. Y. App. filed Aug. 3, 1896. The combination of a forked carrier, studs carried thereby and having a series of radially arranged slots, guiding arms mounted thereon having housings at their lower ends, flat coiled springs arranged in said housings and having one end fitted in the radial slots of the stubs and the other ends bearing against the

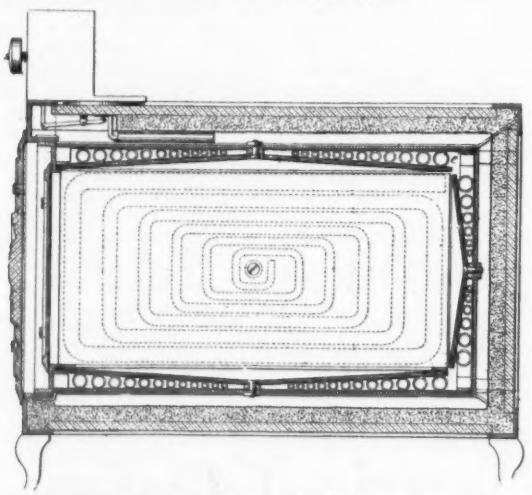
said arms, said shaft being movable within arc-shaped clots in the arms of said fork, and a trolley wheel mounted on said shaft.

574,536. ELECTRICALLY HEATED SAD IRON; W. S. Hadaway, Jr., New York, N. Y. App. filed April 7, 1896. A flat or sad iron having a plane smoothing-surface bounded by two side lines and a base-line, said surface in outline, approximating the form of a triangle, combined with an electric heating-conductor in proximity thereto, but insulated therefrom, said conductor being helically disposed in two or more continuous sections, each section composed of a series of convolutions, the convolutions of the section located at or near the base-line, being greater than the convolutions at or near the side lines whereby the greater heating capacity is located along said base-line.

574,537. AUTOMATICALLY-CONTROLLED ELECTRIC OVEN; W. S. Hadaway, Jr. App. filed May 4, 1896. In an electrical heating device, the combination of a surface to be heated, an electric conductor in sections located in proximity thereto, a series of fixed contacts respectively connected to different points in said sectional conductor, a contact movable across the surface of the fixed contact, an engaging point on said movable contact, a radial arm in position to engage said point, but capable of independent movement, a thermal motor device and separable gearing connecting the motor device and the radial arm, whereby the arm may be set and the extent of free movement thereof may be varied.

574,565. ELECTRIC METER FOR ALTERNATING CURRENTS; G. F. Packard, Fort Wayne, Ind. App. filed Oct. 26, 1896. In an electric meter, the combination of a rotary armature provided with radial vanes, the said armature being adapted to be rotated by the mutually repellent action of the inducing and eddy current fields, said inducing fields being established by the adjacent poles of one or more electromagnets; an energizing coil or coils forming the winding for and exciting said magnets when traversed by alternating electric currents; and a registering train or indicating device.

574,579. CIRCUIT FOR ANNUNCIATOR OR TELEPHONE LINES; C. E. Scribner, Chicago, and F. R. McBerty, Downer's Grove, Ill. App. filed May 14, 1896. The combination with a telephone line having at its substation means for producing in the line a momentary signaling-current and at a central station a spring-jack connected with a line, of an annunciator in the line circuit adapted to display its indicator when traversed by current, a shunt or parallel circuit of the annunciator, including a source of current, normally separated switch contacts interposed in said shunt controlled by an electromagnet in the line circuit and other switch contacts in the spring-jack interposed in the shunt circuit adapted to be separated when connection is made with the spring-jack.



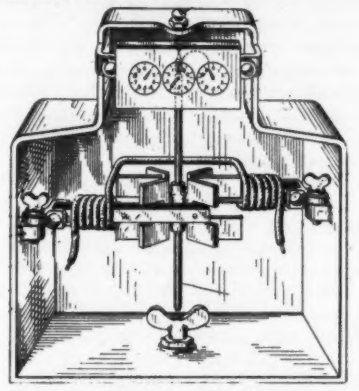
No. 574,537.—Automatically Controlled Electric Oven.

574,632. ELECTRIC RAILWAY; W. M. Schlesinger, Philadelphia, Pa. App. filed Oct. 12, 1887. In combination with a line of railway rails electrically connected to form a working conductor, another conductor separate from the track rails, and an electrically propelled car having separate traveling collectors between its motor and said conductors, one of the collectors for the rail conductor being normally out of contact and adapted to be manually placed in contact with said rail.

574,642. TELEPHONE SWITCHBOARD; H. J. Swarts, Knoxville, Tenn. App. filed Dec. 24, 1895. A switchboard consisting of a series of vertically disposed annunciator-boards arranged around a common centre, subscribers' line plugs arranged in a series corresponding with the annunciators of each board between said board and the said centre and provision whereby the operator can be stationed at the said centre.

574,654. TELEPHONE RECEIVER; R. S. Barnum, Chicago, Ill. App. filed April 3, 1896. The combination in a telephone-receiver of a magnet supporting bridge placed at the end of the receiver-case adjacent to and parallel with the diaphragm, set-screws inserted into the end of the case, and having their axes parallel with that of the case and their heads beneath the bridge, so as to form stops or rests therefor while their heads are partially exposed, and securing screw projected through the bridge into the case.

574,669. ELECTRIC CLOCK; C. M. Crook, Chicago, Ill. App. filed Dec. 12, 1895. In a chronometer, in combination with the winding-shaft, drum or barrel, the cam thereon; an electromagnet and its armature, and a lever which carries the latter, having an abutment adapted to operate against the cam; the lever having an arm adapted to be stopped by collision with the frame in the movement caused by the attraction of the magnet for the armature, one of said colliding parts having an adjustment screw by which the collision may tend, with respect to the approach of the armature to the magnet poles and of the abutment to the end of the cam-track, whereby the armature may be prevented from contact with the poles, and the abutment prevented from giving a blow to the cam.



No. 574,565.—Electric Meter for Alternating Currents.

574,707. AUTOMATIC TELEPHONE-EXCHANGE SYSTEM; L. G. Bowman, New York, N. Y. App. filed July 18, 1896. An automatic telephone system comprising a plurality of subscribers' lines and a central office, having a revoluble drum for each of said lines, said drums being provided each with peripheral contact-plates corresponding in number to the subscribers' lines, connections between the subscribers' lines and their respective contact-plates on the drum and a second connection from each subscribers' line to its respective drum and means for moving said connection relative to the drum to engage the contact-plates thereof successively and cut its line into circuit with a second line.

574,739. ELECTRICAL MEASURING AND INDICATING APPARATUS; J. F. Kelly, Pittsfield, Mass. App. filed June 16, 1896. In a measuring and indicating instrument the combination of a vibrating needle and stationary quadrants separated from each other by a wall of insulating material.

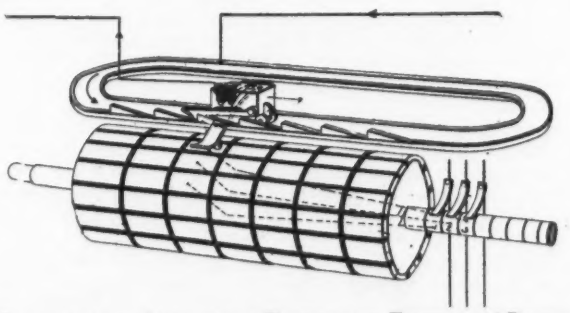
574,745. ELECTRIC HEATER; J. E. Meek, New York, N. Y. App. filed March 5, 1896. The combination in an electric heater, the body of which is made of flexible, insulating and non-conducting material, of two or more continuous and separately insulated conductors, in substantially the same plane, each of which extends to substantially all parts of the heater, and woven into the fabric thereof, and induction and eduction current-conveyors.

574,761. AGITATOR FOR TELEPHONE TRANSMITTERS; S. B. Rawson, Elyria, O. App. filed Jan. 14, 1895. A centrally pivoted dust transmitter in a telephone, a lever for removably holding the receiver, said lever provided with a slot at its inner end and engaging a pin attached to said transmitter, all in combination, whereby the operating of said lever will impart motion to said transmitter and thereby agitate the dust contained therein.

574,819. TROLLEY; W. L. Pepper, Philadelphia, Pa. App. filed April 2, 1895. The combination with oppositely disposed trolley arms, each constructed in pivoted sections, the upper sections of the arms being pivoted to the trolley-wheel and the lower sections of the arms pivotally attached to a support, of a shaft journaled between the trolley arms, provided with spring-controlled crank-arms at its ends, a lever carried by the said shaft and a link connection between the ends of the lever and the lower sections of the said trolley-arms.

574,826. SECONDARY BATTERY-SUPPORT OR GRID; J. J. Rooney, Brooklyn, N. Y. App. filed Feb. 12, 1896. A grid for a secondary battery-plate made up of layers of strips of wood felt laid together in sets of rows which cross each other so as to form pockets or holes between the rows.

574,828. INSULATOR; B. D. B. Smock, Wickatunk, N. J. App. filed March 10, 1896. An insulator, consisting of a body portion with an opening to receive a wire and a ribbed wedge adapted to be inserted to hold the wire therein.



No. 574,707.—Automatic Telephone Exchange System.

574,856. ELECTRIC ALARM DEVICE; G. V. Trott, Chicago, Ill. App. filed April 10, 1896. In a circuit-controlling device for electrically operated alarms, the combination with a plurality of possible contacts through which the circuit is operated, of an adjustable member adapted to close the circuit through any one of the said contacts, and a rotatable contact-piece adapted to prevent the actuating current from being transmitted to the alarm when the said contact-piece is in a single adjusted position during its rotation.